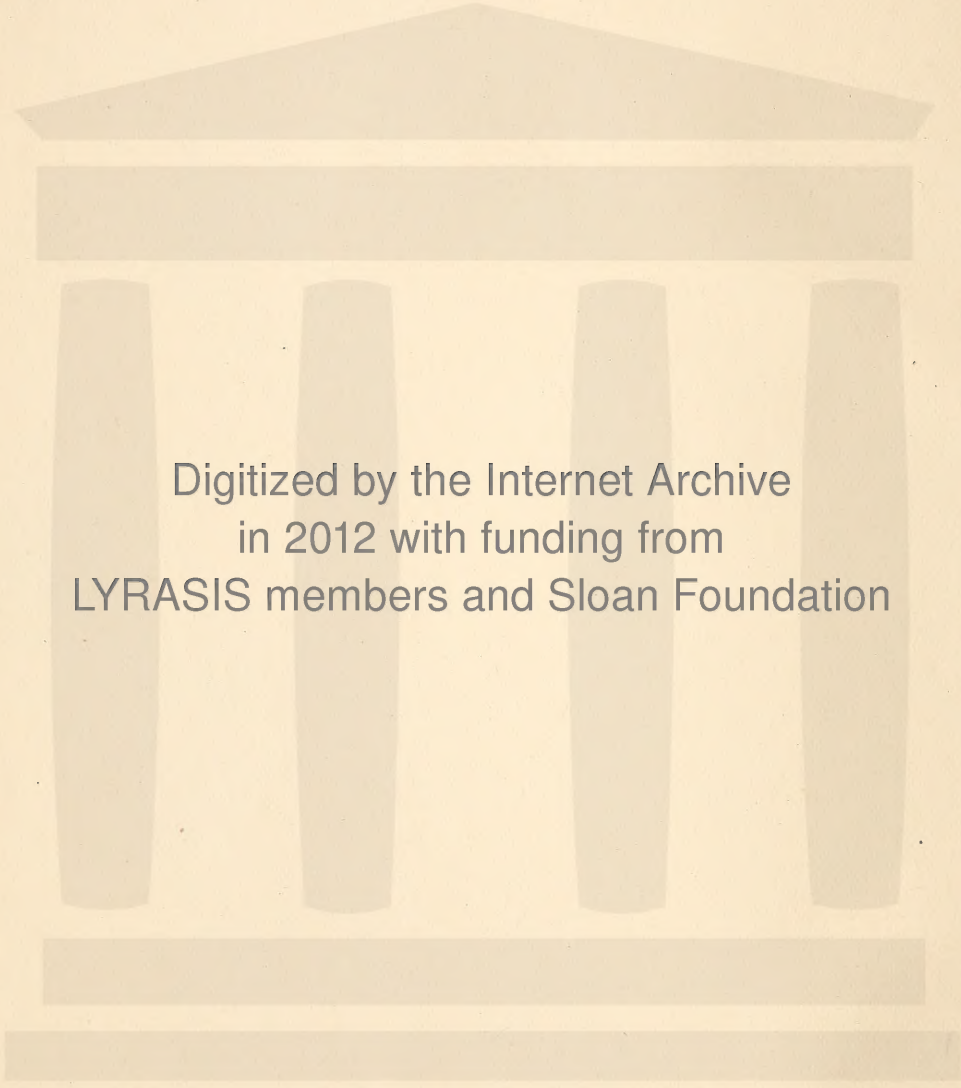
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The Work during 1894 of the

N. C. Agr. Experiment Station

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

SEVENTEENTH ANNUAL REPORT

JANUARY 31, 1895
336

Publications will be sent to any address in North Carolina upon application.

N. C. Agricultural Experiment Station,
Office of Director,
Raleigh, *January 31, 1895.*

To His Excellency Elias Carr,
Governor of North Carolina.

Sir: I have the honor to submit herewith a report of the operations of the North Carolina Agricultural Experiment Station for the year ending December 31, 1894.

This report is made in accordance with the following portion of section 3 of the Hatch Act of the Congress of the United States for the maintenance of agricultural experiment stations in the various States and Territories:

"It shall be the duty of each of the said stations, annually, on or before the first day of February, to make to the Governor of the State or Territory in which it is located, a full and detailed report of its operations, including a statement of receipts and expenditures."

Trusting that this report will prove satisfactory to your Excellency,

I am, very respectfully yours,

H. B. Battle,
Director.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

BOARD OF TRUSTEES OF THE A. AND M. COLLEGE.

W. S. PRIMROSE, *Chairman*, Raleigh.

W. F. GREEN ..... Franklinton.	W. E. STEVENS ..... Clinton.
D. A. TOMPKINS ..... Charlotte.	J. H. GILMER ..... Greensboro.
H. E. FRIES ..... Salem.	W R. CAPEHART ..... Avoca.
N. B. BROUGHTON ..... Raleigh.	J. R. MCLELLAND ..... Mooresville.
W. R. WILLIAMS ..... Falkland.	R. W. WHARTON ..... Washington.
J. B. COFFIELD ..... Everett's.	T. B. TWITTY ..... Rutherfordton.

J. F. PAYNE ..... Alma.

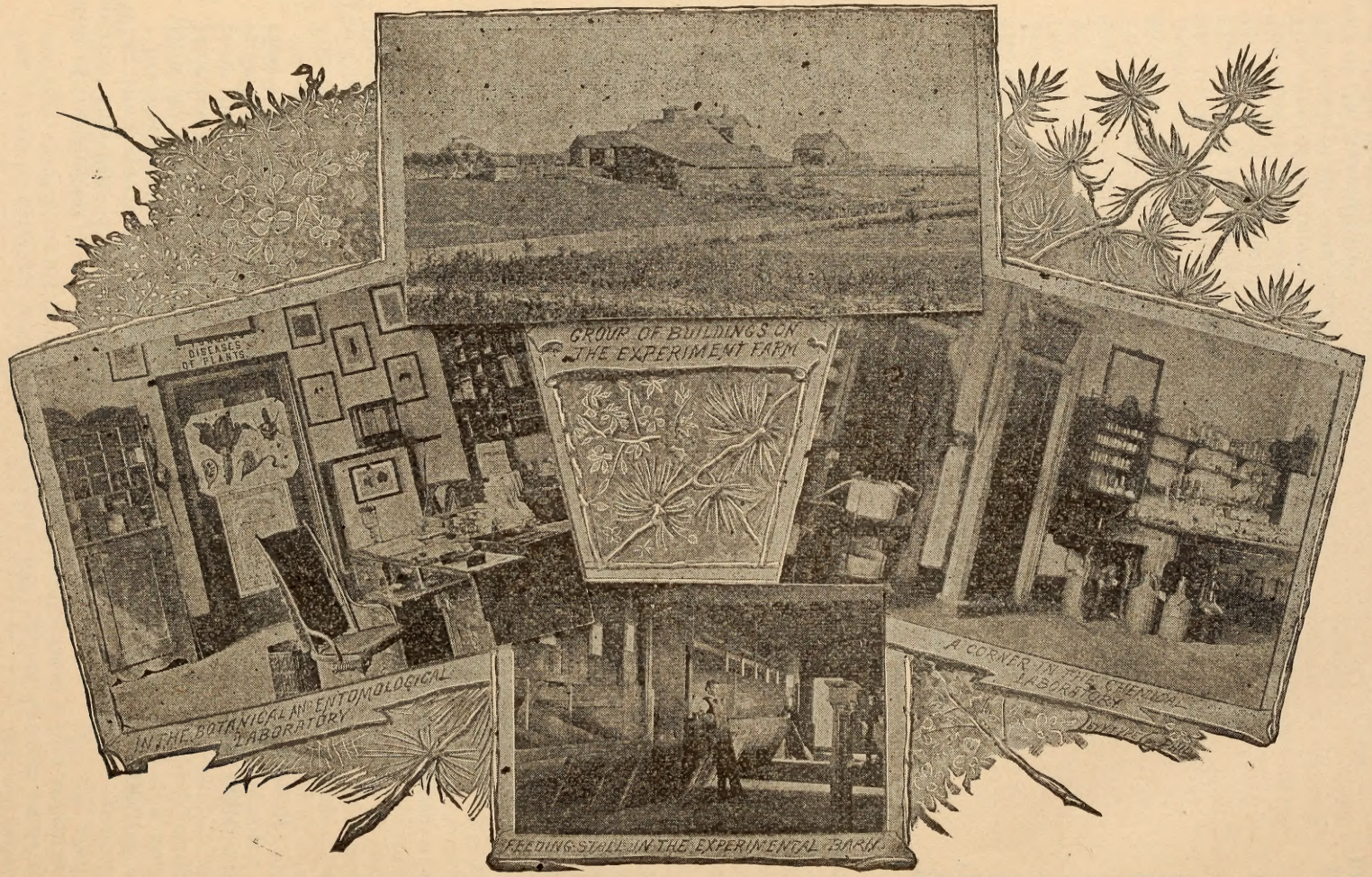
STATION COUNCIL.

A. Q. HOLLADAY, *Pres. A. and M. College.* W. S. PRIMROSE, H. B. BATTLE,

OFFICERS OF THE EXPERIMENT STATION.

H. B. BATTLE, PH. D ..... Director and State Chemist.
F. E. EMERY, M. S ..... Agriculturist.
GERALD MCCARTHY, B. SC ..... Botanist and Entomologist.
W. F. MASSEY, C. E ..... Horticulturist.
C. F. VON HERRMANN (U. S. Weather Bureau) ..... Meteorologist.
F. P. WILLIAMSON, D. V. S ..... Consulting Veterinarian.
B. W. KILGORE, M. S ..... Assistant Chemist.
F. B. CARPENTER, B. S ..... Assistant Chemist.
W. M. ALLEN ..... Assistant Chemist.
C. B. WILLIAMS, B. S ..... Assistant Chemist.
ALEXANDER RHODES ..... Assistant Horticulturist.
ROSCOE NUNN (U. S. Weather Bureau) ..... Assistant Meteorologist.
A. F. BOWEN ..... Secretary.

RALEIGH, N. C.



SOME VIEWS OF THE N. C. AGRICULTURAL EXPERIMENT STATION AT RALEIGH.

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SEVENTEENTH ANNUAL REPORT

OF THE

DIRECTOR

OF THE

N. C. AGRICULTURAL EXPERIMENT STATION,

FOR 1894,

TO THE GOVERNOR.

The North Carolina Agricultural Experiment Station, including the Fertilizer Control Station and the State Weather Service, during the past year has concluded a period of its life embracing one-sixth of a century. It appears that the present is a fitting time to record something of its aims and objects, the results that it has accomplished, and in general the particular work that has been done for the agricultural, horticultural, as well as for the material interests of North Carolina.

The Experiment Station as it now exists, is a growth of years and experience. It could not have sprung into life in its present state, for the complete knowledge of the needs of such an institution, as well as the fullest means and widest facilities for conducting it, were lacking.

On the 12th of March, 1877, on the day of the ratification of the law by the General Assembly, the Station was organized as a part of the North Carolina Department of Agriculture. The Station thus organized was the first in the Southern States, and the second in America.

The objects desired by its establishment were twofold:

1st. To protect the farmers of the State from the fraudulent fertilizers then flooding the market; and

2d. To carry on experiments in the field (in the language of the act) "on the nutrition and growth of plants with a view to ascertain what fertilizers are best suited to the various crops of this State, and whether other crops may not be advantageously grown on its soil."

Besides these two principal objects, the new institution was designed to be a place of information on all subjects pertaining to agriculture or horticulture or other material interests,

where farmers and others could seek information in regard to farming or any of its allied branches. A place where marls, soils, compost, fertilizers or any fertilizing ingredient could be examined and their value reported; where feeding stuffs could also be analyzed and their true worth ascertained; where insects injurious to vegetation could be studied and remedies recommended; where varieties of field crops, small fruits, orchard fruits, grasses and clovers, and forage plants could be tested; where seeds could be examined for their purity and vitality, and where special and detailed information could be secured as the result of combined study, reference, and experience, in both scientific and practical branches.

The Station was first located at Chapel Hill in connection with the State University. It was moved by legislative enactment to Raleigh in 1881, where it is still located. Dr. A. R. Ledoux was its first director until November, 1880, and was succeeded by Dr. C. W. Dabney, Jr., until September, 1887, when the present director took charge. In April, 1886, an experiment farm was equipped for the purpose of conducting practical field and stable work, and in December, 1886, the State Weather Service was organized for the purpose of distributing by telegraph, weather indications, cold wave and frost warnings, and to study the weather and climate upon growth of crops in every section of the State. Up to 1888, the Station was supported by the license tax on fertilizers, after which time it received the benefit of the Hatch fund from the general government. After this fund was received, the scope of the work was greatly enlarged, and all parts of it were put upon a systematic and permanent basis.

In 1888 the Station, by legislative enactment, was transferred from the Department of Agriculture to the N. C. College of Agriculture and Mechanic Arts, with which it is still connected. As now constituted, the work of the Station falls under the following divisions: Executive, Agricultural, Chemical, Botanical, Entomological, Horticultural, Meteorological, Veterinary, and the Division of Publication.

What the N. C. Agricultural Experiment Station has accomplished for the Agricultural, Horticultural, and Material Interests of North Carolina.

This may be imperfectly summed up as follows:

1. It has discovered and prevented fraud and adulterations in the sale of commercial fertilizers and chemicals, and by the proper control of the fertilizer trade, immense amounts

in cash and prospective crops have been saved to the farmers of the State.

2. By this wholesome restraint, the grade of the fertilizers has been increased and at the same time the price of the same has been reduced.

3. In endeavoring to extend practical information of an agricultural character, it has printed hundreds of separate and distinct bulletins in editions of thousands each, the aggregate distribution of which runs into millions of copies.

4. The Station has inaugurated a system of educational bulletins, designed especially to spread abroad special information upon important subjects. This has been done with the view of giving the work as practical cast as possible. No less than 25 separate bulletins of this educational series have already been issued.

5. One hundred and eighteen of the regular and technical bulletins, embracing all character of agricultural and horticultural information have been issued. The pages in each range from 8 to 150. The editions of each of the late ones number 16,500 copies. The regular bulletins are written always in plain language for popular reading and embrace subjects of immediate practical value.

6. Sixty-three of the monthly meteorological records from every section of the State have been issued, including at present the work of 73 observers each month. Seven annual reports of the weather of the State have been recorded, and monthly, seasonal and annual means and normals for each locality, section, and the whole State, are being accurately determined.

7. Our splendid climate is thus being shown to the world, and correct climatic conditions learned that will assist in the profitable growth of other crops.

8. One hundred and seventy-four weekly bulletins from 1888 through 1894 have been issued telling of the weekly progress of the crops and the effect of the weather upon them.

9. A system of press bulletins was inaugurated in 1890, in order to send to various newspapers the result of the Station's work. An extension of the same plan by distributing the short articles of these bulletins by plate matter has been successfully pursued. These plans have been of incalculable benefit to individual farmers.

10. Analyses of fertilizers are regularly and promptly made during the spring and fall seasons of each year, and these analyses are published immediately for the benefit of purchasers, and every two weeks during the fertilizer season.

11. By the Station's urgent advice, the plan of home composting is being widely used to the great advantage of the lands, and the further saving in the values of high-priced commercial fertilizers.

12. The phosphate beds of the State have been carefully explored and accurately mapped.

13. Acid phosphate made from native phosphate has been distributed and experimented with in every section of the State, and its value shown to equal any similar material.

14. The marls of the State have been studied and many hundreds of beds analyzed and their value reported.

15. In order to extend its usefulness, the Station has analyzed many samples from individual farmers and others, these samples embracing fertilizers, composts, mucks, marls, phosphates, mineral waters, chemicals, minerals, and in fact the greatest variety of materials.

16. Has analyzed the samples of coal from the coal survey in the Deep and Dan rivers.

17. Has made investigations upon the possible adaptability of the sugar-beet to various sections of the State, and a large number of samples grown and analyzed.

18. Has made analyses for the State Board of Health of a large number of potable waters, articles of food, etc.

19. Has made an exploration of the pyrites deposits in the State to ascertain their applicability for the manufacture of sulphuric acid. A large number of beds were examined and analyzed.

20. The fishing interest of the east in reference to the catch of "fat backs" for the manufacture of fish-scrap for fertilizer purposes and for oil has been investigated.

21. Has conducted for many years past special tests of seeds for purity and vitality, and now an efficient laboratory standard is the result.

22. Materials for making complete fertilizers and home mixtures for various crops, as well as the needs of the various crops, have been exhaustively studied.

23. Special work upon cotton-seed, and the products made from them has been conducted.

24. The by-products of the rice industry have been studied and their value shown.

25. Early in its existence the Station made a special study of kainit and its uses for various crop applications, and this work was about the first undertaken in America upon potash salts.

26. Finely ground phosphates or "floats" have been criti-

cally examined as to their fineness and availability for fertilizing applications.

27. Horn, leather, and wool waste have been studied as possible adulterations in commercial fertilizers.

28. The following list embraces the number and variety of samples analyzed and tested during each successive biennial term since the organization of the Station:

April, 1877, to January 1, 1879	249
January 1, 1879, to January 1, 1881	760
January 1, 1881, to January 1, 1883	909
January 1, 1883, to January 1, 1885	1,095
January 1, 1885, to January 1, 1887	1,077
January 1, 1887, to January 1, 1889	993
January 1, 1889, to January 1, 1891	1,234
January 1, 1891, to January 1, 1893	1,486
January 1, 1893, to January 1, 1895	1,828
Total	9,631

A classification of these samples is contained in the following list:

Commercial fertilizers	3,438
Composts and manures	75
Phosphates	303
Marls	435
Soils	395
Cotton-seed and products	106
Chemical and fertilizer ingredients	210
Grasses and seeds examined	1,268
Health analyses	64
Feeding stuffs	162
Minerals identified	1,008
Ores examined and assayed	138
Drinking waters	458
Mineral and boiler waters	603
Coals	35
Sugar-beets	62
Fertilizer analyses of fodders	11
Fodder analyses in connection with digestion experiments,	193
Urine analyses in connection with digestion experiments,	34
Milk, cream and butter	62
Cotton plant experiments	117
Tobacco, leaf, plants, stems, roots, etc	201
Special nitrate experiments	60
Miscellaneous	193
Total	9,631

29. The officers of the Station have aided largely in the displays to illustrate the resources of North Carolina at the expositions at Atlanta in 1881, at Boston in 1883, at Raleigh in 1884, at New Orleans in 1885, at Raleigh in 1891, and at Chicago in 1893.

30. The Station always in the past and is now promptly and cheerfully attending to every request made upon it for particular advice in any branch of agricultural or horticultural industry, or in any other way to benefit the material interests of the State.

31. Many farmers' institutes, and other public meetings, have been attended, and addresses made by various members of the Station staff.

32. Field tests have been conducted in co-operation with prominent farmers, and many results of value have been reached.

33. By distributing a large number of copies of the work on diseases of the horse, published by the U. S. Department of Agriculture, many animals have been saved, as evidenced by reports of the fact by their owners.

34. Further, in the line of veterinary work, a special bulletin on a disease in pork has been issued, and also special investigations have been undertaken upon tuberculosis and other cattle diseases.

35. In order to encourage the raising of improved breeds of stock and to advance the dairy interests in the State, and believing in them lay far greater permanent prosperity than any one-crop system, no less than sixteen distinct publications in editions of many thousands each have been issued to further these improvements.

36. The Station instituted the plan for the establishment of experimental committees by the various sub-alliances and granges, and other organizations in the State. The object of these committees was to study and discuss improved methods of agriculture, and to aid in this the Station kept in close communication with them by answering queries, suggesting topics for consideration, sending them its publications, and in other ways.

37. The publications of the Station are absolutely free to any in North Carolina who will make application for them. Wide distribution of this fact is made by placards at all post-offices, by continual offers in the press of the State, and in various other ways.

38. The publications go to every one of the thousands of post-offices in North Carolina, and not one is omitted. The mailing lists are consequently rapidly increasing.

In order to bring more prominently into view the work of the separate divisions, the following summaries have been prepared:

HOW THE AGRICULTURAL DIVISION HAS BEEN OF BENEFIT.

39. By the publication of a bulletin on silos and silage, which gives:

a. The amount of space required to store silage for different numbers of farm stock.

b. The construction of a silo with bill of materials.

c. Experience with silos and coatings to retard rotting of walls.

d. Methods of harvesting and storing silage.

e. A number of economical rations for milch or beef cattle, with and without silage.

f. An appendix showing details of the construction of round silos.

40. The Station has demonstrated that mules and driving horses may safely be fed on silage, by having thus fed three seasons as long as silage lasted during each season.

41. Four and one-fourth tons of silage and one to one and one-half tons of hay are sufficient coarse foods for one full-grown horse or mule at work in one year, and this amount can be grown on one acre in one year, with enough silage to spare for two others.

42. It has been demonstrated that there is a small profit in feeding beeves on cotton-seed hulls and meal.

43. The profit from husbanding the manure made in this feeding may be greater when applied on our worn lands than that on the stock in feeding.

44. After liberal applications of manure from well-fed stock, it has been demonstrated that very poor lands "catch" well in grass seeding, and yield good hay, which is too expensive to be purchased.

45. That feeding for beef may be done at any time of year when fresh food and suitable animals are at hand.

46. That animals fed in warm weather should be kept in well-aired darkened stables to keep off flies.

47. Care should be exercised in feeding late in summer, when hulls and meal may be damaged by chemical changes, indicated by rancid smell in hulls and by changing color in meal.

48. Digestion experiments, many of which have already been concluded, help the agricultural interests:

a. By ascertaining the true composition and feeding value of various ordinary foods, which can be easily raised or procured on every farm.

b. In showing feeders how much of each kind of food may be used to combine rations most economically and to secure the best return from a given amount of food.

c. By calling attention to the valuable home products for food, and indicating how to use them to the best advantage.

49. The true digestibility of the more common food-stuffs already determined, are cotton-seed, cotton-seed hulls and meal, peavine hay, corn silage, sorghum fodder silage, and bagasse, crimson clover hay, corn meal, Johnson-grass hay, and soy-bean hay. These have been fed alone and in various combinations with each other.

50. By co-operative field experiments with fertilizers in every part of the State, it has helped to a better understanding of the requirements of the soil and more rational use of fertilizers. This saves expenditures and secures better returns from the applications made.

51. Co-operative tests with various crops have brought some of the best varieties in notice and have aided in a better knowledge of the methods of cultivation.

52. Press bulletin articles have been issued on various topics and given broadcast to the press, have reached many farms and have carried in few words what may be of great value to each in condensed experience, and in outlining ways by which very desirable ends may be reached.

53. The special value of improving lands for wheat culture by turning under ripe peavines has been fully demonstrated, and an average increased yield of more than ten bushels per acre of wheat was the result.

54. A plan of hillside ditching has been shown, which can easily be followed and with very valuable results.

55. The results of feeding tests with common stock foods have been carefully recorded in separate publications and widely distributed.

56. The results of the digestion work with cattle on similar stock-foods and combinations have been published and widely copied in the agricultural literature of the day. Few States have done so much in this particular line of agricultural research, and one so replete with useful and valuable information.

57. There have been five distinct bulletins issued describing the co-operative field tests with fertilizers and with varieties of field crops, including cotton, corn, tobacco, wheat, peanuts, and potatoes. These tests have been made by practical farmers in every section of the State.

58. Much has been done in the way of introducing in vari-

ous sections of North Carolina valuable crops, such as crimson clover, soy beans, and different grasses and forage plants.

59. By personal correspondence with farmers in every section of the State, very much general and specific information to every inquirer has been given.

60. The object-lessons afforded to visitors at the Experiment Farm is also a potent aid, because very many farmers visiting Raleigh or the State Fair can look it over and find some new points in practice to adopt.

61. The better points of practice here illustrated are taught to the students at the Agricultural and Mechanical College, who will carry back to their homes and adopt many things which they will find to be to their advantage.

HOW THE CHEMICAL DIVISION HAS BEEN OF BENEFIT.

The Chemical Division has helped the farmer and others:

62. By determining, in conjunction with the Agricultural Division, the digestibility of 18 leading cattle foods and fodders, and more than 20 rations of them. This is of benefit to the feeder:

a. In giving him a better knowledge of the value of the different foods.

b. By showing the digestibility and value of the rations.

c. By indicating the best and most economical combinations of foods for feeding.

63. In particular these experiments have shown:

a. The clear and heavy loss of digestible nutrients from roasting cotton-seed, to say nothing of the increased cost of roasting.

b. Have indicated the beneficial effect of cotton-seed meal by increasing the digestibility of coarse fodders, such as cotton-seed hulls and corn silage.

64. By presenting the principles of stock-feeding, and explaining and discussing the nutrients of foods and their offices.

65. By stating the "feeding standards," showing amounts of foods and nutrients to be fed for different purposes; by presenting tables showing amounts of nutrients in different quantities of our leading foods; and by explaining methods for making rations by using the foregoing data.

66. By analyzing and disseminating knowledge of the composition and value of various forage plants, wild and cultivated grasses, grains, seeds, and by-products used as stock foods or promising well for such use.

67. By analyzing the corn plant, cowpea-vine and soy bean at different stages of growth to determine the best time to cut them for obtaining the greatest amount of food material of best quality.

68. By analyzing old and new foods on sale, presenting opinion as to their value, and exposing fraud and adulteration.

69. The material known as "Compound Extract of Salyx" has been analyzed several times; the exorbitant price is shown at which it is sold for preserving food or certain preservatives for milk, butter and other foods, and the danger from their use has been pointed out.

70. The sugar content of varieties of sorghum grown on the farm has been determined with reference to a knowledge of those best suited for syrup-making, and those promising best for making sugar.

71. Experiments have been made with a view of improving the methods of continuing the sorghum crop and in making syrup from it.

72. By the examination of drinking waters, disease has no doubt often been prevented, and aid given in obtaining a pure water supply.

73. As a result of the analysis of mineral waters, many properties have been developed.

74. By the analysis of soils, fertilizing materials, mucks, marls, phosphates, limestones, coals, minerals, ores, etc., much valuable information has been given to farmers and others.

75. Investigations in the laboratory have shown that 94.5 per cent. of the phosphoric acid, and 85.5 per cent. of the potash in cotton-seed meal, and 94 to 98 per cent. of potash in tobacco stems have been shown to be available by chemical methods.

76. Investigations of the value of various other crude fertilizer materials have been made and the results reported.

77. By collecting and analyzing the dung and urine from a cow fed 21 pounds cotton-seed hulls and 4 pounds cotton-seed meal per day, it was ascertained that 82.4 per cent. of the fertilizing constituents of the food were in the excrement, which was worth 6.6 cents per day, and that the urine contained 38.4 per cent. of the weight, and 36.9 per cent. of fertilizing value of the total amount of the excrement.

78. By demonstrating the cause of "burning" and "scorching" of foliage by arsenites when used as insecticides.

79. By giving means of preventing such injury.

80. By investigating the combination of insecticides and fungicides, and indicating those that could be safely combined.

81. By educational exhibits at expositions and fairs, illustrating the general lines of work and results of the division.

82. By the study of fertilizers and fertilizing materials, and methods for their analysis and valuation, the fertilizer trade and the fertilization of crops have been placed on a more rational and scientific basis.

83. The curing of tobacco has been studied, and the relative cost, yield and value of the product from the different methods have been accurately determined.

84. Many samples of leaf tobacco have been examined in comparison with that grown here, and stalks and stems have been tested for their fertilizing qualities.

85. The examination of the beds of marl and phosphate has been of benefit:

(*a*). By showing their location, extent, and composition.

(*b*). In describing how and what soils are most particularly helped by application of these materials.

(*c*). And by saving the cost that otherwise would go for the purchase of similar material elsewhere.

HOW THE BOTANICAL AND ENTOMOLOGICAL DIVISIONS HAVE BEEN OF BENEFIT.

86. The botanical division has tested for purity and vitality over 600 samples of grass, clover and vegetable seeds bought in the market or sent in by farmers.

87. Gross adulteration of such seeds in our markets has been seldom met with since the Station published its work in seed-testing, and local dealers have become more careful in their purchases and manner of handling seed stocks.

88. Farmers have been shown the relative values of good clean seed at a fair price, and cheap, deteriorated and weed-infested seeds at any price.

89. A vast amount of technical work, relating to the establishment of a national laboratory standard of quality and a standard method for testing seeds has been completed.

90. The proper quantity of seeds per acre for grass lands has been calculated, so that rational mixtures of different varieties can be made and any desired percentage of the different species secured.

91. Seeds of new and promising forage plants have been imported from Europe, Asia, Africa, and Australia, and

these plants have been grown and studied for several seasons at the Station farm in order to learn their true worth before disseminating them among the farmers of the State.

92. A very extensive field trial of all obtainable varieties of the cow pea and soja bean have been carried on for two seasons and valuable results obtained, which have been made available to our farmers.

93. The native and introduced weed pests of this State have been studied, and a bulletin giving the results has been published.

94. By newspaper articles and lectures, the division has endeavored to awaken a sentiment among the farmers of the State in favor of legal enactments to prevent the importation and spread of noxious weeds, such as the Canada thistle, dodder, and other costly pests.

95. One regular bulletin of 20 pages, and several parts of bulletins, have been published on the subject of plant diseases. These have included:

(*a*). Descriptions and illustrations of diseases, sufficient to enable any intelligent farmer to recognize them when they attack his crops.

(*b*). Remedies and hygienic measures to prevent the spread of these diseases.

(*c*). Illustrations of the best apparatus for applying remedies.

96. One regular bulletin of 32 pages, and several parts of bulletins, have been devoted to noxious and beneficial insects. These bulletins have included:

(*a*). Name, illustrations, descriptions, and life histories of all the more common and important noxious and useful insects found in this State.

(*b*). Remedies and precautionary measures for repressing noxious insects.

(*c*). Illustrations of apparatus for applying remedies.

97. Laboratory and field studies have been undertaken with the purpose of discovering a practical method for spreading, artificially, certain contagious bacterial diseases to which insects are more or less liable.

98. A handbook on the best agricultural grasses and forage plants has been prepared. This contains 100 pages and includes:

(*a*). Descriptions and illustrations of all the best grasses and clovers.

(*b*). Plain directions for sowing these plants, both as single species and as mixtures, adapted to various sorts of soil and for different purposes.

(*c*). The quantity of each kind of seed of known vitality and purity, per acre, is given, so that guess work need not be depended upon in laying down land to grass.

(*d*). Tables of analyses, showing the food and manurial value of each kind of hay, are given, and thus their relative money value per ton calculated.

(*e*). The diseases to which grasses are subject are briefly treated, and the value of irrigation, manures, etc., for grasses are explained.

99. A large number of short and practical papers have been contributed to the press bulletin issued by the Station. These deal with various questions in economic botany and entomology, and are calculated to be timely and of immediate interest to farmers.

100. Lectures have been delivered before the State and County Horticultural Societies, and exhibits made of spraying apparatus and chemicals.

101. Numerous papers on economic botany and entomology have been contributed to different newspapers which circulate largely in this State.

102. Many hundreds of specimens of noxious and useful plants and insects have been identified for farmers and their properties reported upon by letter to the senders.

103. Many photographs of root-systems of grasses, clovers and grain-plants have been made to show the relation which should exist between the root-growth and methods of cultivation of different crops.

104. Personal letters have been written to enquirers for information of a botanical or entomological character.

105. All the more important discoveries in economic botany and entomology, made by European scientists, have been promptly made available to the readers of the Station bulletins and newspapers of the State.

106. An extensive series of photographs relating to the Station and its work have been contributed to the Station exhibit at the World's Fair in Chicago. Specimens of apparatus, records, and blanks, used in the botanical work of the Station, have also been contributed to the same exhibit.

107. In conjunction with the Horticulturist of the Station, a bulletin treating of orchard and garden fruits and their diseases has been published. The botannical and entomological portion of which includes:

(*a*). Illustrations and descriptions of parasitic fungi.

(*b*). Remedies for the same and apparatus for applying them.

(*c*). Illustrations and descriptions of noxious insects.

(*d*). Remedies for the same and apparatus for applying them.

(*e*). List of birds and quadrupeds injurious to fruit in North Carolina.

108. In conjunction with the Agriculturist of the Station, a bulletin treating of leguminous crops has been prepared and published. This includes full notes of a two-years' test of these plants and discussions of their value:

(*a*). As improvers of the soil.

(*b*). As forage for animals.

(*c*). Their fungous and insect parasites.

109. A bulletin on the chestnut and its weevil has been prepared and published. This includes a full discussion of the losses entailed by the depredations of this pest, illustration and description of the weevil, with suggestions for protecting chestnut orchards.

110. A bulletin of 74 pages on seed-testing, its methods and value, has been prepared. This is an exhaustive resumè of the subject, including:

(*a*). The uses and advantages of seed-testing.

(*b*). Experience of European countries in seed-testing.

(*c*). Methods and apparatus used in seed-testing.

(*d*). Structure and physiology of seeds.

111. A bulletin on the native medicinal plants of the State and the cultivation of exotic and medicinal and essential oil-bearing plants has been partly completed and will be published during the year 1895. This will include:

(*a*). Illustrations and descriptions of all the important wild medicinal plants of the State, with their particular uses, and antidotes for such as are poisonous.

(*b*). Illustrations, descriptions, and uses of all the exotic medicinal plants found to grow successfully upon the Station farm.

(*d*). Methods of growing essential oil-bearing plants and distillation of the same.

112. A bulletin on the parasites of domestic animals is nearly ready for publication, including insect parasites of horses, cattle, sheep, hogs, dogs, cats, and fowls, with remedies for the same.

113. Notes have been made preparatory to a bulletin on

the fungous and insect parasites of cereal grain crops. This bulletin will be ready early in the winter of 1895.

114. Notes on a bulletin on the insect pests of the household have been made, and a bulletin on this subject will be ready in the fall of 1895.

115. A special bulletin upon tests of useful forage grass is now ready for publication, and in conjunction with the Agricultural Division, will include hay-making, the laying down and care of grass lands, and diseases and insects attacking grasses.

HOW THE HORTICULTURAL DIVISION HAS BEEN OF BENEFIT.

116. The Horticultural Division has made numerous tests of vegetables and fruits and published the results, and is engaged in raising seedling fruits to improve our ordinary varieties.

117. Is testing all the most promising new small fruits as they appear, and has produced seedling strawberries that promise well.

118. Has introduced nearly 40 varieties of figs, and has distributed free for trial over 6,000 fig trees.

119. Is making experiments in tea culture with prospects for success, and has sent tea seed to over 100 applicants.

120. It is also engaged in investigating the culture of flowering bulbs for commercial purposes, with the prospect of introducing a new culture of value.

121. Has made experiments in protecting grapes and other fruits from fungous diseases.

122. Has developed a plan for making the late crop of Irish potatoes certain, which is likely to prove of great value to the State, since these potatoes are rapidly coming in demand in the North for seed.

123. Has built a grapery for culture of exotic grapes under glass, and is investigating the question of the profit of forcing fruits and vegetables under glass, with the view of instructing our growers in this profitable branch of horticulture.

124. Has inaugurated and is continuing a series of educational bulletins on practical horticulture, including vegetable, fruit, and commercial floriculture.

125. The division has put itself into close correspondence with farmers and truckers in all parts of the State, and has answered thousands of letters asking information on all sorts of topics.

126. Has attended Farmers' Institutes in nearly all sections of the State and addressed meetings of farmers in this and other states on subjects of interest.

127. Has contributed articles on subjects of interest to farmers in all the leading agricultural and horticultural journals.

128. Has made the horticultural work of the Station of constant value in the practical training of classes of students at the College of Agriculture and Mechanic Arts, and through them the work will be spread all over the State.

129. Special bulletins, describing the result of tests at the Station of varieties of fruits and vegetables, have been detailed as they were reached and widely disseminated.

130. Timely publications of interest have been distributed concerning the culture of figs, the late crop of Irish potatoes, onions, and the growing of celery.

131. A special bulletin on "Facts for Farmers," in plain language for farmers' reading, has been sent out broadcast over the State. The object of this publication was to describe conditions affecting crop-growth, saving of manure, crop rotation, fertilization of crops, and kindred information.

132. Another bulletin of great importance, is one on the culture of orchard and garden fruits, prepared by the horticultural and botanical and entomological divisions; is a complete manual upon the subject, as evidenced by its completeness and generally recognized value.

133. The propagation of flowering bulbs for commercial purposes has been considered in a specially prepared publication, which paves the way for a very profitable industry in North Carolina.

HOW THE METEOROLOGICAL DIVISION (STATE WEATHER SERVICE) HAS BEEN OF BENEFIT.

134. The work of the State Weather Service is arousing much greater interest than ever before, and is educating the people to the great importance of studying the effect of weather and climate upon agricultural interests, which is paramount.

135. The Service has rendered practical benefit to the people of the State by the distribution of daily weather forecasts, frost and cold-wave warnings, which may be put to immediate use in the everyday operations of the farm:

(*a*). The daily forecasts, issued for 36 hours in advance and distributed by telegraph to 60 places, and by mail to

nearly 500 towns in the State, are steadily improving in accuracy, and hence in value to the farmer.

(*b*). The frost and cold-wave warnings yearly save thousands of dollars of damage to the tobacco, trucking, and fruit interests by giving information in advance of the approach of sudden cold spells in autumn and spring.

136. The issue of the weekly Weather Crop Bulletin during the season of growing crops, gives valuable information to both farmers and merchants of the current condition of crops and prevents outside misrepresentation, which would be detrimental to their interests.

137. The Service has made a fair determination of the climatic conditions of the State, with special reference to the distribution of temperature and rainfall, and the local climatic peculiarities of many places have been ascertained.

138. Charts of normal temperature and rainfall have been published, which will be found of great value in studying various important questions of the relations of the soil, crops, and climate.

139. The accumulation of records of the meteorological elements, now already carried on for eight years, is indispensable for the study of important questions, the solution of which has not yet been attempted by the Weather Service, because the series of records is not long enough :

(*a*). Such questions are, for instance: What regions of the State are climatically more suited to certain crops than others? What conditions are most favorable for the production of the largest crops of tobacco? Of cotton? Of corn? What are the conditions of the weather which cause insect pests to thrive?

140. By the publication of monthly and annual records and their distribution, it has made widely known the splendid climate which North Carolina possesses, including particular points and sections in the State.

The Work Accomplished During the Past Year.

As has been previously stated, the North Carolina Agricultural Experiment Station was established in March, 1877, with a twofold object in view—first, to act as a Fertilizer Control Station, and second, as an Agricultural Experiment Station in the true sense of the word. Until 1887 the Station was supported by the State from the tax on fertilizers, and, as organized up to that time, was a part of the North Caro-

lina Department of Agriculture. By legislative enactment of that year the Station was made a part of the North Carolina College of Agriculture and Mechanic Arts, and the funds derived from the United States Hatch Act for the maintenance of experiment stations in the various states and territories were appropriated to it. The Station receives also an appropriation from the North Carolina Department of Agriculture for the work of the Fertilizer Control. The report of the work of the Station for the year 1894 is embraced under each of its legal functions, the first being:

I. THE FERTILIZER CONTROL STATION.

The beneficial results accomplished by the Fertilizer Control from the moment of its organization to the present time are too well known to be necessary to repeat them here. A history of the fertilizer trade in the State since 1876 would be interesting and would show the vast advantages that have accrued from its organization. The adulterated chemicals and low-grade fertilizers (now happily very seldom seen) that have been detected and brought to light, and the millions of dollars that have undoubtedly been saved, illustrate the value that the Control has been to North Carolina farmers.

The Fertilizer Control During 1894.

It will be remembered that up to 1891 the fertilizer trade was controlled by a license tax on each brand. Commencing from that year the tonnage charge has been in vogue.

In order to show the character of the trade for a number of years past, the subjoined table is inserted, giving a description of the different brands on sale in the State during previous years. It will be noted, however, that as licenses did not lapse with the calendar year, a single brand could extend through portions of two years. The numbers, therefore, while showing the number of brands licensed, do not show the actual number on sale during each year. The large increase in the number of brands after 1890 is due to the change from the license tax on each brand to a definite charge on each ton.

	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	1893	1894
Acid phosphates or simple superphosphates	8	10	11	7	9	11	10	9	12	16	59	81	86	86
Superphosphates with potash	9	15	15	10	10	9	8	7	5	4	13	24	22	24
Ammoniated superphosphates	40	55	61	56	63	66	58	62	62	63	178	232	264	284
Ammoniated superphosphates without potash	--	--	--	--	--	--	--	--	--	--	15	12	5	12
Potash, salts and chemicals	--	--	--	--	--	--	--	--	--	--	22	29	38	44
Fish scrap	--	--	--	--	--	--	--	--	--	--	4	5	4	2
Miscellaneous	2	4	6	5	3	4	1	1	2	1	4	6	8	10
Totals	59	86	92	80	85	90	77	79	81	84	295	389	427	462

The number of brands accredited to the several States is as follows, and furnishes an interesting basis for comparison:

	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1892	1893	1894
Massachusetts	3	3	--	2	2	3	1	4	6	2	2	3	3	3
Connecticut	1	2	2	4	3	3	1	2	1	1	1	--	--	--
New York	3	6	5	3	2	4	3	1	1	2	1	8	10	8
New Jersey	3	3	1	1	1	2	3	2	4	4	5	3	7	2
Delaware	2	2	2	2	2	4	4	4	3	3	3	--	5	6
Maryland	21	25	45	42	30	31	35	29	25	28	25	98	106	93
Pennsylvania	--	--	1	1	--	--	1	--	1	--	--	5	12	7
Virginia	7	9	15	17	20	18	21	14	12	12	16	96	106	146
North Carolina	3	3	6	6	8	9	10	11	13	14	18	78	89	98
South Carolina	5	6	9	14	12	11	11	10	13	15	13	85	82	97
Georgia	--	--	--	--	--	--	--	--	--	--	--	13	7	1
Missouri	--	--	--	--	--	--	--	--	--	--	--	--	--	1
Totals	47	59	86	92	80	85	90	77	79	81	84	389	427	462

The foregoing and the following table are more particularly valuable for comparison before 1891. During those years the number of brands indicated, in the best way obtainable, the amount of trade handled by the manufacturers in the separate States. After 1891, the number of brands are only of passing interest, because they do not give any indication of the sales of fertilizers.

A casual glance at the above table will show how the number of fertilizer brands accredited to the States of Virginia, North Carolina and South Carolina have increased. This is especially the case with North Carolina, where the increase has been sixfold within the ten years previous to 1891.

As further illustrating this increase, the following calculation is inserted, which shows the proportion of the brands on sale which were manufactured in the three States before mentioned, as compared with the total number sold for the different years:

THE NUMBER OF BRANDS OF FERTILIZERS MANUFACTURED IN THREE STATES, VIRGINIA, NORTH CAROLINA AND SOUTH CAROLINA, FOR THE YEARS 1880 TO 1894, IN PER CENTS OF THE WHOLE MUMBER.

	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1892	1893	1894
Virginia, N. Carolina, S. Carolina	31.92	30.50	34.88	40.21	50.00	44.70	46.67	45.45	48.10	50.62	55.95	66.61	64.87	73.81

In reference to North Carolina alone, considering only the number of licensed brands before 1891 as showing the relative amount of fertilizer sold, the change is more decided:

NUMBER OF BRANDS OF FERTILIZERS MANUFACTURED IN NORTH CAROLINA FOR THE YEARS 1880 TO 1890, IN PER CENTS. OF THE WHOLE NUMBER.

	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890
North Carolina--	6.38	5.08	6.97	6.52	10.00	10.47	11.11	14.30	16.46	17.28	21.43

The increase from 1883 to 1890 has been nearly fourfold. The following extract is taken from the Report of 1888, six years ago, and gives a prediction which is surely becoming true: "What does this change foretell? Considering the number of brands as indicative of the amount sold, these figures prove almost conclusively that the home manufacturers are gradually driving the other more distant competitors from the field; that the distance from the source of supply of the various ingredients from the market where the fertilizers are sold, and the consequent high freight which these fertilizers must pay, are proving each year a more effectual barrier to their entering the State. Taking our own State and the two adjoining, it is plainly seen that the three, while they controlled one-third of the trade eight years ago, now control one-half. North Carolina alone, eight years ago, controlled only one-sixteenth; now controls one-sixth. With this increase—and there is now no reason now why it should not continue—it is not hazardous to assert that *in ten years one-half of the commercial fertilizers sold in North Carolina will be made in North Carolina.* An additional reason for this assertion is that the State, either alone or by calling on South Carolina, can furnish all the raw ingredients, except potash, sufficient to make all of the fertilizers needed here."

The prediction made in 1888 can now, at the close of the year 1894, be seen to be surely coming to pass. The year 1891 was the transition period between the privilege tax system and the tonnage system, during which time some brands were sold under both systems. Manufacturers who came in for the first time only purchased tags for a portion of the year. Nothing definite, therefore, can be stated for 1891. But in 1892 the records are complete, and show the exact number of tons placed on the market for which tags were sold. Comparing with the whole number of tons sold in North Carolina in 1892, for the fiscal year closing November 30, the North Carolina manufacturers handled 36.95 per cent. of the whole number. The same calculation for 1893 shows 37.73, and 42.15 per cent. for the year 1894. Even this

estimate is too low, because no tags were used in many cases when the manufactories dealt at their doors directly with the farmers. Again, cotton-seed meal is not subject to tax, and is very largely used for fertilizing purposes. It is impossible to state how large this amount really is, but it should be also added to the total accredited to home manufacturers.

Carrying on, therefore, the preceding table, the growth of North Carolina manufactories and the trade controlled by them, can very readily be seen. The statement shows that the prediction made in 1888, that in ten years one-half of the fertilizers sold in North Carolina would be made in the State, is rapidly becoming true.

TABLE SHOWING THAT THE PREDICTION OF 1888 IS BEING VERIFIED.

	1880	1882	1884	1886	1888	1890	1892.	1893	1894
North Carolina manufacturers sold in the various years in percentages of whole fertilizer trade—	6.38	6.97	10.00	11.11	16.46	21.43	36.95	37.73	42.15

The increase of the whole fertilizer trade in the State from 1892 to 1893 was about 30 per cent. Very probably the home manufacturers were not equipped to handle such a large increase, and this may account for the small increase (as shown in the above table) in 1893 over the year previous.

RELATIVE AMOUNT OF FERTILIZER BUSINESS IN 1894.

The following table shows the number of firms doing business in North Carolina, together with the location of the fertilizer factories and the relative amount of business done during 1894, for the fiscal year ending November 30, as determined by the sale of tags for the same period:

FIRMS DOING BUSINESS IN NORTH CAROLINA IN 1894, WITH RELATIVE AMOUNT OF SALES.

	Number of Firms.	Number of Brands.	Average number of brands per firm.	Relative Amount of Business Handled.
Firms located in North Carolina	30	98	3	42.15 per cent.
" " " Virginia	21	146	7	37.84 " "
" " " South Carolina	17	97	6	8.69 " "
" " " other States	43	121	3	11.32 " "
Total	111	462	5	100.00 " "

It is noticeable that a larger number of firms from distant States register brands, but their trade is trifling compared with North Carolina firms. The average number of brands per firm is twice as great in South Carolina than in North Carolina. Virginia has a still greater proportion as com-

pared with North Carolina. It is also noticeable that North Carolina handles nearly one-half of the trade, and that North Carolina and Virginia handle nearly four-fifths.

Digest of Fertilizer Laws Now in Force.

In order to give a short and concise statement of all laws now in operation in regard to the fertilizer inspection and control, the following carefully prepared digest of existing laws is inserted:

No manipulated guanos, superphosphates, commercial fertilizers or other fertilizing material shall be sold or offered for sale unless a tonnage charge of twenty-five cents per ton has been paid. Each barrel, package or bag shall have attached a tag representing this fact, which tags shall be issued by the Commissioner of Agriculture according to regulations prescribed by the Department of Agriculture. The Department of Agriculture has power at all times to have samples collected of any fertilizer or fertilizing material on sale, which must be taken from at least ten per cent. of the lot selected. These samples are taken from the goods in the hands of dealers after they are shipped from the manufactories, and accordingly represent the true grade of fertilizers offered for sale.

Every package of fertilizer offered for sale must have thereon a plainly printed label, a copy of which must be filed with the Commissioner of Agriculture, together with a true sample of the fertilizer which it is proposed to sell, at or before the shipment of such fertilizer into the State, and which label must be uniformly used and not changed during the year. This label must set forth the name, location and trade-mark of the manufacturer; also the chemical composition of contents and real percentage of the ordinary ingredients claimed to be present, together with date of analyzation, and that all charges have been paid. There must be no variation in the guaranteed percentages, but the bags must be branded with the exact chemical composition of the contents. No fertilizer can be sold with a content less than eight per cent. of available phosphoric acid, two per cent. of ammonia, and one per cent. of potash. Cotton-seed meal is exempted from paying the tonnage charge; also land plaster, agricultural lime, oyster-shell lime, marl, and bulk materials for manufacturing purposes.

It is a misdemeanor, and a fine of ten dollars for each bag, for an agent or dealer to offer for sale any such fertilizer or fertilizing materials not properly tagged, or a consumer to remove it, or a railroad agent to deliver it. Goods kept over from last season must be tagged to represent this fact, and all dealers are required to report to the Commissioner of Agriculture the amount on hand at the close of the fiscal year, on November 30.

Any fertilizer or fertilizing material that does not contain the ingredients as represented by the label is liable to seizure, and, after being established on trial, its value is recovered by the Board of Agriculture. Any person who offers for sale fertilizers or fertilizing material without having attached thereto labels as provided by law, is liable to a fine of ten dollars for each separate package—one-half, less the cost, going to the party suing, and the remainder to the Department; and if such fertilizer is condemned, the Department makes analysis of the same and has printed labels placed on each package, giving the true chemical ingredients of the same, and fixes the commercial value at which it may be sold. The Department of Agriculture can require agents of railroads

and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them. The Experiment Station analyzes samples of fertilizers taken by the official inspectors, and publishes the same whenever needful.

Increase in Number of Brands, and the Difficulty in a Proper Control.

During the year 1890, the last year of the license tax system, there were 84 brands of commercial fertilizers licensed to be sold in North Carolina. It is very easy to see, under those circumstances, where the number of brands was limited, how much easier it was to supervise the fertilizer trade than under the present tonnage system, where the number of brands is almost unlimited. Under the operations of the latter system, the number of brands, including fertilizing ingredients, offered for sale in the State, has increased from 84 in 1890, to 295 in 1891. For the year 1892, closing with the fiscal year ending November 30, this number had increased to 389, an increase of over 30 per cent. in a single year. During the year 1893 the number had increased to 427, and during the year 1894 the number has further increased to 462. There appears to be almost no limit to this increase. The difficulties met with in the proper control of the fertilizer trade, under these conditions, accordingly have been very greatly increased.

Valuations of Fertilizers, and how they are Determined.

The valuations of the three constituents, available phosphoric acid, ammonia, and potash, are intended to give the market price for cash at the seaboard of the ingredients making up a fertilizer. The cash prices for small lots in bags, free on board cars, are intended. These valuations are made up early in January of each year, to run through the spring and fall seasons. It is expected that there will be variations in the market price of the ingredients during the course of the year, but experience has shown that this variation will be slight. This is because fertilizing materials are largely contracted for in advance before the opening of the year, and in many cases a large majority of the fertilizers are already manipulated before the beginning of the season.

The valuation of the constituents are fixed by a careful examination of existing conditions of the trade, the markets at important centres, and from actual quotations given by

seaboard manufacturers and dealers upon the various ingredients used for manipulating fertilizers. These quotations are for cash in small lots free on board and bagged.

The relative commercial valuation given to the three valuable ingredients for the years 1893 and 1894 was—

For available phosphoric acid	5	cents per pound.
For ammonia	15	" " "
For potash	5	" " "

The valuation for phosphoric acid and potash remain the same as for the years 1891 and 1892. The ammonia for 1893 and 1894 (15 cents per pound) is two cents more per pound than for the valuation for the two preceding years. This increase was caused by commercial advances in the price of ammoniates.

These figures were based on the actual retail cash price of the unmixed ingredients at the seaboard, in bags.

By the commercial valuation of a fertilizer, using these figures, a farmer could see the actual cash worth of the unmixed ingredients used in the fertilizer, at the seaboard. For interior points freights, of course, must be added. In the bulletins showing the analyses of fertilizers, a table giving the various freight rates from seaboard to interior points has been inserted for the convenience of readers.

KIND OF FERTILIZER.	YEAR.	AVAILABLE PHOS. ACID.		AMMONIA.		POTASH		RELATIVE SEABOARD VALUE OF UNMIXED INGREDIENTS.	
		By Analysis.	By Guarantee.	By Analysis.	By Guarantee.	By Analysis.	By Guarantee.	By Analysis.	By Guarantee.
Acid phosphates	1890	12.92	12.25	----	----	----	----	$ 12.92	$ 12.25
	1891	12.21	12 06	----	----	----	----	12.21	12.06
	1892	12.25	12.01	----	----	----	----	12 25	12.01
	1893	12 93	12.04	----	----	----	----	12.93	12.04
	1894	13.73	12.00	----	----	----	----	13.73	12.00
Acid phosphates with potash	1890	12.04	10.90	----	----	1.77	1.42	13.81	12.32
	1891	11.17	10.29	----	----	1.66	1.50	12.83	11.79
	1892	11.22	9.97	----	----	2.06	1.53	13.28	11.50
	1893	10.38	9.60	----	----	1.78	1.40	12.16	11.00
	1894	11.27	9.77	----	----	1.77	1.47	13.01	11.24
Ammoniated superphosphates with potash	1890	9.11	8.53	2.41	2.29	2.02	1.71	18.36	17.11
	1891	8.11	8.24	2.59	2.51	2.20	1.88	18.08	17.65
	1892	8.70	8.10	2.63	2.46	2.65	2.12	19.24	17.60
	1893	8.37	8.05	2.59	2.47	2.56	1.97	18.70	17.43
	1894	9.04	8.06	2.85	2.76	2.51	2.21	20.10	18.55

The foregoing table shows the average percentage composition, by analysis and by guarantee, of fertilizers sold in 1890, in 1891, in 1892, in 1893, and in 1894. The relative seaboard value, both by analysis and guarantee, is calculated on the basis of the last valuations employed, viz., for 1894: for available phosphoric acid and potash, five cents per pound; for ammonia, fifteen cents per pound. Except in one or two slight cases, all the materials are higher in grade than is guaranteed.

Bulletins Containing Fertilizer Analyses.

The plan adopted during the season of 1892 for the first time, for publication of analyses of fertilizers, has been continued during 1894. This plan proved very acceptable to farmers and buyers, and gave them a complete record of the standing of the various brands already analyzed. Early in January of 1894 an analysis bulletin was published to include the various analytical determinations in detail, namely: Moisture, soluble, insoluble, reverted, and available phosphoric acid, nitrogen and ammonia, potash, and relative commercial valuation. There were also given the guaranteed percentage of available phosphoric acid, ammonia, and potash, and the guaranteed value, using the Station's figures for the valuation of the unmixed ingredients at the seaboard. All analyses that were made during the year 1893, both in the spring and fall seasons, were inserted therein. As buyers do not purchase their fertilizers to a great extent before March 1st, this gives ample time to distribute the bulletins to the hands of those who desire to use them in their purchases. This first complete bulletin was sent to the full mailing list of some 14,000 names. Upon the back of the title page was stamped: "Analyses for 1894 will be sent out every two weeks only to those who apply. Write postal to Dr. H. B. Battle, Raleigh, N. C."

Replies to this notice were used as a basis by which to send out the bi-weekly fertilizer analyses, which were issued every two weeks during the winter and spring season of 1894. These bulletins contained only the main results of analyses of each sample, viz.: Available phosphoric acid, ammonia, potash, mechanical condition of fertilizer, and relative commercial value, together with the percentages and valuation guaranteed by the manufacturer. These short forms were chosen to facilitate printing the bulletins, the object being to place the analyses before those who need them just as soon

as could be done with the least delay. For most practical purposes these short statements of analyses answer as well as the complete forms in giving the result only of the detailed work which has been done upon them.

Mechanical Condition of Fertilizers.

An improvement has been made in the statement of the analysis by the insertion of the mechanical condition of the fertilizer. As a fertilizer in a fine state of subdivision is of more value because it is more available to the plant in the soil than a coarse one, the mechanical condition of each sample as it is received from the inspector is stated. In the same way a dry fertilizer is more easily handled and distributed than a damp or moist one, and is consequently of greater value. Heretofore this question has not been considered, but the inevitable result, by calling attention to the matter, will be that more care will be bestowed upon it by the manufacturers, and consequent improvement of the condition of the fertilizer. Another beneficial effect will be to educate purchasers and users to the importance of finely divided fertilizers and those that are free from excessive moisture.

Fertilizers and their Constituents.

Few of the farmers who read analyses of fertilizers and profit by the statements in their purchases, understand the composition of fertilizers and the constituents that are ordinarily contained in such fertilizers. In connection with the published analyses in the bulletin at the beginning of the past season of 1894, it was endeavored to explain these matters. The following subjects were treated: The manufacture of commercial fertilizers; the ingredients used for making fertilizers, *i. e.*, those furnishing phosphoric acid, embracing mineral phosphates, phosphates of fossil origin, phosphates from bone, slag phosphates, phosphates from guano, and phosphates from miscellaneous sources; those furnishing nitrogen (or ammonia), embracing chemicals, ingredients of animal origin, and of vegetable origin; those furnishing potash, embracing potash salts, and those from organic origin. Adulterations in fertilizers were also discussed, as well as bulky portions of fertilizers, and when analyses are made for farmers, including a statement showing the necessity for accurate sampling. The analysis of a fertilizer was also con-

sidered, and the terms used were explained, also how the valuation of constituents are determined, how values per ton are calculated, and how they can be utilized by farmers.

II. THE AGRICULTURAL EXPERIMENT STATION.

The second object designed by the State laws of 1877 was the establishment of a true Agricultural Experiment Station. Its functions were to be both scientific and practical, and experiments were to be carried on in various branches of agriculture. In the language of the act, "shall carry on experiments on the nutrition and growth of plants, with a view to ascertain what fertilizers are best suited to the various crops of this State, and whether other crops may not be advantageously grown on its soil." This work was conducted from time to time, previous to 1887, after which time its scope was largely augmented by the provisions of the Hatch Act in providing the means to carry these objects into effect.

The work of the Station, thus enlarged, now embraces—

I. CHEMICAL AND MICROSCOPICAL WORK, including
1. The analysis of all fertilizers legally on sale in the State.
2. The analysis of agricultural chemicals, of composts and home-made fertilizers, and all materials from which they can be made.
3. The analysis of soils, marls and mucks.
4. The analysis of feeding stuffs.
5. The examination of seeds with reference to their purity, and capacity to germinate.
6. The examination of grasses and weeds.
7. The study of insects injurious to vegetation.
8. The analysis of milk, butter and other dairy products.
9. Investigations of fungous diseases of plants, and remedies designed to eradicate them.
10. Such other chemical and microscopical investigations as are demanded from time to time.

II. EXPERIMENTAL WORK IN THE FIELD, STABLE, DAIRY, AND LABORATORY, to include
1. The effect of different fertilizers on various soils of the State.
2. The study of improved methods for the cultivation of the staple crops.
3. The study of the best treatment of worn-out lands.
4. The study of the best system for the rotation of crops.
5. Chemical investigations, with practical experiments with cattle, on the value of the various forage crops, especially those common in North Carolina.
6. Investigations upon the growth of new crops for this climate, in comparison with those we now have.
7. The construction of the silo, and value of ensilage.
8. The study of the growth of cattle using different feeding stuffs.

Investigations in the production of milk and butter under different conditions, and with various implements.

10. Digestion experiments with stock, to ascertain the real value of various food stuffs.
11. Experiments with the various feeding rations, to ascertain how far the feeding standards can be relied on.
12. Tests to compare the different varieties of fruits and vegetables, to ascertain those worthy of trial.
13. Investigations designed to develop the vineyard and trucking interests of the State.
14. Investigations upon the diseases of cattle and domestic animals, and the dissemination of information concerning the treatment of various diseases.
15. Such other work from time to time as may be deemed advisable for the interest of the agriculture of the State.

III. The Collection and Distribution of Meteorological Data, such as will directly aid the various agricultural and horticultural industries of the State. The work is of benefit in
1. The distribution of telegrams to various portions of the State, giving the probable state of the weather for the succeeding twenty-four hours.
2. A foreknowledge of the coming of frosts and cold waves, thereby protecting fruit, trucking and tobacco interests.
3. The collection of various meteorological data; and thus, by obtaining a more perfect idea of the various climatic conditions, to extend to other localities the crops found useful in portions of this and other States.
4. The collection and distribution of weekly reports showing the effect of the weather on crops during successive periods of their growth.

IV. A Bureau of Information upon all subjects connected with the agricultural industries of the State. Under this head is included
1. Publications of the Station, embracing six different classes of bulletins and three of reports. These publications contain the results of the investigations carried on, as well as a resume of work done elsewhere, in order to instruct or advance the general agricultural interests.
2. Direct correspondence, through the various divisions of the Station, with individual farmers, information being always given as promptly and carefully as possible by those most competent to do so.
3. Personal contact of the Station force with farmers and others at institutes and fairs, visits to farms, etc.

V. Samples for Examination.—Samples, when sent by citizens of the State, for chemical or other examination, will be examined and their value reported free of charge, under certain conditions and stipulations—
1. If the experimental work of the Station will not be retarded thereby.
2. If the samples come from the sender's own lands.
3. If they are of sufficient public interest, and the Station is free to publish the results.
4. If the samples are taken and sent according to the Station's printed forms, and are fully described.

Divisions of the Station.

In order to facilitate the work of the Experiment Station, it has been subdivided into—

1. Executive Division.
2. Chemical Division.
3. Agricultural Division.
4. Botanical Division.
5. Entomological Division.
6. Horticultural Division.
7. Meteorological Division.
8. Veterinary Division.
9. Division of Publication.

The Station Staff.

As at present constituted, the Station staff includes—

H. B. Battle, Ph. D	Director and State Chemist.
F. E. Emery, B. S	Agriculturist.
Gerald McCarthy, B. Sc	Botanist and Entomologist.
W. F. Massey, C. E	Horticulturist.
C. F. von Herrmann (U. S. Weather Bureau)	Meteorologist.
F. P. Williamson, D. V. S	Consulting Veterinarian.
B. W. Kilgore, M. S	Assistant Chemist.
F. B. Carpenter, B. S	Assistant Chemist.
W. M. Allen	Assistant Chemist.
C. B. Williams, B. S	Assistant Chemist.
Alexander Rhodes	Assistant Horticulturist.
Roscoe Nunn (U. S. Weather Bureau)	Assistant Meteorologist.
A. F. Bowen	Secretary.

Equipment.

The headquarters of the Station are in the Agricultural Building, immediately north of the Capitol. In the north wing are located the offices, the chemical laboratories and storerooms. On the basement floor is the document room, where are kept the publications of the Station. On the third floor is situated the mycological laboratory, botanical and entomological work-rooms; also the meteorological division of the Station, organized as the State Weather Service, co-operating with the United States Weather Bureau. On the roof of the building and on the third floor are located the various instruments for recording meteorological observations. A thirty-five foot staff for displaying flags to disseminate weather forecasts is also upon the roof, where the signals are visible to a considerable distance.

The Experiment Farm is located about one mile and a half west of the city, and adjoins the Fair grounds of the State Agricultural Society. It is in close proximity to the grounds of the North Carolina College of Agriculture and Mechanic Arts, and the students have access to the experi-

ments, and study their progress and their results. On the farm are located the experimental dairy, silos, and barn, in which are the cattle under test for production of beef, milk, and other purposes. Field-crop tests are also conducted, as far as is possible, upon the land of the farm. Here, also, is the field and plant-house work of the horticultural division. The experiment farm is connected by telephone with the city offices. The electric cars on the Hillsboro street line of the city stop in easy walking distance of the farm.

Publications of the Station.

The publications of the Station have heretofore been classified to facilitate preparation as well as preservation. The bulletins and reports being of such varied character, and mailed to different lists, there must necessarily be some confusion unless this be done.

Accordingly, the following classification has been adopted:

A. Bulletins—*Regular.* Each edition 14,000 to 18,000 copies. For popular reading, with scientific terms avoided as far as possible. Numbered consecutively 82, 83, 84, etc. Sent to all names on the Station mailing-list. Last issued during 1894 was No. 110.

B. Bulletins.—*Technical.* Each edition 3,000 copies. Numbered consecutively 1, 2, 3, etc.; also with corresponding number according to date of issue, 77b, 80c, etc. Sent only to scientific list and exchanges. Summaries of these issues appear in regular bulletins. Last issued during 1893 was No. 7—91d. This series of bulletins have now been merged into A.

C. Bulletins.—*Meteorological Division (State Weather Service).* Each edition 1,800 copies. Numbered consecutively 1, 2, 3, etc. Sent only to meteorological list and to exchanges. Subject-matter is mainly meteorological data of various stations in North Carolina. Last issued during 1894 was No. 63.

D. Bulletins—*Special.* Each edition varying in number from 500 to 60,000 copies. For special purposes, as the demand requires. Numbered consecutively 1, 2, etc. Sent only to special names, as occasion demands. This series includes the bi-weekly fertilizer bulletins. Last issued during 1894 was 21.

E. BULLETINS.—*Weekly Weather Crop.* Each edition 1,600 copies. Numbered consecutively 1, 2, 3, etc., during the year of issue. Printed during 1888, 1889, 1890, 1891, 1892, 1893 and 1894. Gives weekly the effect of the weather upon crops during the growing season. Sent only to crop bulletin list and exchanges. Last issued during 1894 was No. 26.

F. BULLETINS.—*Press.* Each edition 600 copies. Numbered consecutively 1, 2, 3, etc. Short reading articles for newspaper columns. First number published May 24, 1890. Sent to newspaper exchanges and to chairmen of experimental committees of alliances and granges. Last issued during 1894 was No. 66.

G. ANNUAL REPORTS OF THE STATION.—Each edition 3,000 copies. Numbered consecutively with years, 1–1878, 2–1879, 3–1880, etc. Prior to 1888 these reports contained results of the year's work, and took the place of the separate bulletins which appeared thereafter. The annual reports now contain copies of the regular bulletins issued during the year. Sent to exchanges only, and not to general mailing-list. Last issued was 16th for 1893.

H. ANNUAL REPORTS OF THE METEOROLOGICAL DIVISION, *constituting the State Weather Service.* Each edition 2,000 to 4,000 copies. Numbered consecutively with years, 1–1887, 2–1888, 3–1889, etc. Includes monthly and annual means of meteorological data at various stations in North Carolina and for the State, with other records made and work done during the year; also copies of meteorological bulletins of series C issued during the year. Sent to meteorological exchange list only. Last issue was seventh annual for 1893.

I. BIENNIAL REPORTS OF THE STATION. Sent to the Governor for transmission to the General Assembly. Each edition 500 to 3,000 copies. Numbered consecutively First, Second, etc. These reports are demanded by local authorities, and are not intended for general distribution. Last issue was Eighth Biennial Report for the years 1893 and 1894.

J. INFORMATION BULLETIN —Designed to be distributed for the purpose of collecting information concerning practical and useful plans of farm management or methods of cultivation of different crops, etc., to be collated thereafter for use in general bulletins. The last issue for 1894 was No. 5.

Since the above plan was adopted, it has been found that some confusion occurred in the classification of A and B (Regular and Technical bulletins). To remedy this, it was determined to merge the latter series into the former, and give a popular summary of the technical work, which summary is alone to be sent to the general list of farmers throughout the State. The full detailed report of the technical work is mailed, as usual, to the scientific and exchange lists. Others can secure each of these publications by special application therefor. This plan prevents wasteful distribution of bulletins to those who do not have the time or the inclination to investigate the detailed portions of the technical work, and supplies to farmers only what they most generally wish to know, *i. e.*, the results of the work.

The title page of the Station's regular publications has been somewhat changed in order to lay greater stress upon the subject-matter of the bulletin. It is believed by this plan that the attention of readers will be more attracted to the subject and a greater interest in it will be caused.

Publications During the Year 1894.

During the year 1894, seventy-eight distinct publications have been issued, subdivided as follows:

Series	A—17	bulletins,	containing	506	pages.
"	C—12	"	"	200	"
"	D— 6	"	"	80	"
"	E—26	"	"	26	"
"	F—10	"	"	10	"
"	G— 1	"	"	50	"
"	H— 1	"	"	140	"
"	J— 5	"	"	5	"

Total during 1894, 78 bulletins, containing 997 pages.

A. OF THE REGULAR BULLETINS, 17 ISSUES.

No. 94.—January 1, 1894. 20 pp.

Horticultural Tests and Results with Garden Vegetables, Fruits, and Bulb Culture.—Table of contents. Tests of garden vegetables: cabbages, melons, garden corn, cucumbers, egg plants, lettuce, onions, potatoes and tomatoes. Result of tests during 1893. Test of fruits: strawberries, raspberries, blackberries, grapes, figs, and peaches. Prevention of grape rot. Grapes under glass. Bulb culture: tuberoses, lilies, gladioli, and hyacinths. Propagation of hardy roses. Acknowledgments.

No. 95.—January 12, 1894. 32 pp.

Fertilizer Analyses and the Fertilizer Control During 1893, including: The Official Analyses of Spring and Fall Samples, and a Description of ingredients in Fertilizers and their Analyses. Table

of contents. The Fertilizer Control Station. Digest of fertilizer laws in force in North Carolina. The manufacture of commercial fertilizers. Ingredients used for making fertilizers, including those furnishing phosphoric acid, nitrogen (or ammonia), and potash. Adulterations in fertilizers. Bulky portions of a fertilizer. When analyses of fertilizers are made for farmers. The analyses of a fertilizer and an explanation of terms used. How the valuation of constituents are determined. How values per ton are calculated, and how they can be utilized by farmers. Analyses of 262 samples of fertilizers taken and analyzed during the year 1893. Freight rates from the seaboard to interior points.

No. 96.—January 20, 1894. 32 pp.

MISCELLANEOUS AGRICULTURAL TOPICS, contained in the press service bulletins of June to December, 1893.

No. 97.—January 30, 1894. 48 pp.

DIGESTION EXPERIMENTS with soy bean hay, cat-tail millet, Johnson grass hay, sorghum fodder and bagasse, peanut-vine hay, cotton-seed meal, cotton-seed hulls, crimson clover hay, corn meal, corn and cob meal, and corn silage. The digestibility of foods and digestion experiments. Terms defined. Different rations experimented with. The animals employed. Summary of results. Table showing composition of foods used in experiments. Table showing summary of coefficients of digestibility and nutritive ratios. Digestion experiments reported in detail with weights of food, analyses of same, analyses of excrement, and resulting percentages digested, with mean nutritive ratio. Summary of coefficients of digestibility.

No. 98.—March 1, 1894. 40 pp.

SOME LEGUMINOUS CROPS AND THEIR ECONOMIC VALUE, including (1), Legumines as improvers of the soil; (2), The cultivation of leguminous plants for forage; (3), The fungous and insect enemies of legumines. Some legumines tested by the Station. The forage plant garden, including full notes taken during growth. The varieties of cowpeas and their comparative merits. Japanese peas and beans.

No. 99.—April 15, 1894. 8 pp.

THREAD-WORM OF PORK (*Trichina Spiralis*).—Description of *trichina spiralis* in flesh and in the encysted form; and mature forms of *trichina spiralis*. Cuts of same.

No. 100.—March 26, 1894. 36 pp.

OUR COMMON INSECTS.—Classification of insects. Insect names and organs. Sub-class of hexapoda, or six-footed insects. Sub-class of arachnida. Sub-class of mirapoda. Sub-class of malacopoda. How to combat noxious insects. How to collect and preserve insects. Books for students of entomology.

No. 101.—August 2, 1894. 20 pp.

THE PROGRESS OF THE DAIRY INDUSTRY IN NORTH CAROLINA.—Descriptive matter showing progress in dairying and reasons therefor. Table showing the progress of the dairy industry in North Carolina from 1879 to 1889, compared with other States.

No. 102.—August 3, 1894. 12 pp.

ENCOURAGEMENT TO THE DAIRY INTERESTS OF NORTH CAROLINA, through the medium of the State Fairs. Testing dairy cows at the

State Fair of 1894. Premium for best dairy cows. Conditions of the tests. Rules for conducting the tests. Records of tests. Application for cows to be tested for premium at State Fair 1894. Food consumed per day by cows for test during ten days previous to test. Result of tests. Testing dairy cows at the State Fair of 1893. Table showing result of dairy test at State Fair of 1893.

No. 103.—August 17, 1894. 24 pp.

MISCELLANEOUS AGRICULTURAL TOPICS, contained in the press service bulletins of January to June, 1894.

No. 104.—August 18, 1894. 4 pp.

WHY PULL YOUR CORN FODDER?—Reasons given for rejecting this method and adopting the better plan of cutting and curing the whole stalk.

No. 105.—September 4, 1894. 12 pp.

THE CHESTNUT AND ITS WEEVIL. NUT CULTURE FOR NORTH CAROLINA.—The chestnut weevil. Remedies. Appendix. Chestnuts. Pecan. Persian Walnuts.

No. 106.—September 6, 1894. 44 pp.

RATIONAL STOCK FEEDING; including (1), Definition of terms and composition and digestibility of foods; (2), Feeding standards; (3), How stock rations can be calculated; (4), Some rations fed in North Carolina, and some rations suggested; (5), Comments of practical stock breeders and feeders. Composition of feeding stuffs. Functions of nutrients. Functions of food in the animal body. Digestibility of feeding stuffs. Average composition and digestible nutrients in feeding stuffs. Coefficients of digestibility. Amount of digestible matter in feeding stuffs. Nutritive ratio. Rations fed to horses. Rations fed to colts. Rations fed to milch cows. Rations fed to beeves. Rations fed to young stock and bulls. Rations fed to sheep. Rations fed to swine.

No. 107.—September 6, 1894. 24 pp.

FLOWERING BULBS IN NORTH CAROLINA, AND THEIR PROPAGATION FOR FLORISTS' USE.—Flowering bulbs in North Carolina. Commercial culture of flowering bulbs. General discussion. Appendix. Plates (drawn from nature) illustrating various bulbs grown in North Carolina.

No. 108.—September 22, 1894. 76 pp.

SEED TESTING, ITS USES AND METHODS.—The uses of seed testing. Seed testing in the United States. The seed control system in Europe. The method of seed control. The physiology of the seed. The structure of the seed. The germination of the seed. The proximate composition of the endosperm. The mineral constituents of the seed. The effect of temperature on the germination process. The action of light and electricity upon the germination of seeds. The action of chemicals upon the germination of seeds. The specific gravity of seeds. The volume-weight of seeds. The life of the plant embryo. The harvest stage. The germinating stage; seed viability. The inert stage. Practical seed testing. Viability, purity and germination of seeds. Seed, their impurities and adulterations. Limit of possible error in seed testing. Method and apparatus used in seed testing. Germinating apparatus. Seed separators. Simple and compound microscopes. Volume-weight apparatus. Sampling apparatus. Analytical balance. Miscellaneous apparatus. Record books and blanks. North Carolina Station records and blanks. Zurich Station blanks. Appendix. Index.

No. 109.—October 15, 1894. 34 pp.

FEEDING TRIALS WITH ANIMALS; including, (1) The effect of cotton-seed hulls and meal as cattle food. (2) Cotton-seed meal as a horse food. (3) Cotton-seed meal for pigs. (4) Cotton-seed meal for calves. (5) Feeding skimmed milk to lambs. (6) A pig-feeding test. (7) A system of feeding young calves.

No. 110.—November 8, 1894. 48 pp.

THE MARLS AND PHOSPHATES OF NORTH CAROLINA.—Includes the geology, distribution, varieties, and uses of marls and phosphates. Description and analyses of all the beds reported. Manufacture of acid phosphate from mineral phosphates.

C. OF THE STATE WEATHER SERVICE DIVISION, 12 ISSUES.

No. 52.—January 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JANUARY, 1894.—Contents: General remarks, tables of normal temperature and precipitation, barometric pressure, air temperature, precipitation, humidity, wind, weather, miscellaneous; dates of halos, coronæ, hail, sleet, fog, frost, snow, etc. Tables of daily mean, maximum, and minimum temperatures, daily precipitation, charts of normal temperature and precipitation for January in North Carolina. Monthly summaries from 63 observers.

No. 53.—February 28, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, FEBRUARY, 1894.—Contents similar to No. 52. Monthly summaries from 68 observers.

No. 54.—March 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, MARCH, 1894.—Contents similar to No. 52. Monthly summaries from 68 observers.

No. 55.—April 30, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, APRIL, 1894.—Contents similar to No. 52. Monthly summaries from 68 observers.

No. 56.—May 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, MAY, 1894.—Contents similar to No. 52. Monthly summaries from 69 observers.

No. 57.—June 30, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JUNE, 1894.—Contents similar to No. 52. Monthly summaries from 70 observers.

No. 58.—July 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, JULY, 1894.—Contents similar to No. 52. Monthly summaries from 71 observers.

No. 59.—August 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, AUGUST, 1894.—Contents similar to No. 52. Monthly summaries from 69 observers.

No. 60.—September 30, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, SEPTEMBER, 1894.—Contents similar to No. 52. Monthly summaries from 68 observers.

No. 61.—October 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, OCTOBER, 1894.—Contents similar to No. 52. Monthly summaries from 66 observers.

No. 62.—November 30, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, NOVEMBER, 1894.—Contents similar to No. 52. Monthly summaries from 62 observers.

No. 63.—December 31, 1894. 18 pp.

MONTHLY METEOROLOGICAL SUMMARY FOR NORTH CAROLINA, DECEMBER, 1894.—Contents similar to No. 52. Monthly summaries from 58 observers.

D. OF THE SPECIAL BULLETINS, 6 ISSUES.

No. 16.—February 24, 1894. 10 pp.

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL.—First bi-weekly edition, season of 1894. Valuation of ingredients for 1894, and digest of fertilizer laws in operation. Freight rates from the seaboard to interior towns. Analyses of 31 samples analyzed by the fertilizer control.

No. 17.—March 10, 1894. 14 pp.

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL.—Second bi-weekly edition. Contents similar to No. 16. Analyses of 74 samples analyzed by the fertilizer control.

No. 18.—March 24, 1894. 16 pp.

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL.—Third bi-weekly edition. Contents similar to No. 16. Analyses of 109 samples analyzed by the fertilizer control.

No. 19.—April 7, 1894. 18 pp.

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL.—Fourth bi-weekly edition. Contents similar to No. 16. Analyses of 169 samples analyzed by the fertilizer control.

No. 20.—April 21, 1894. 20 pp.

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL.—Fifth bi-weekly edition. Contents similar to No. 16. Analyses of 204 samples analyzed by the fertilizer control.

No. 21.—May 22, 1894. 2 pp.

FERTILIZER ANALYSES AND THE FERTILIZER CONTROL.—Sixth bi-weekly edition, issued as a supplement to No. 20. Analyses of 15 samples analyzed by the fertilizer control.

E. OF THE WEEKLY WEATHER CROP BULLETINS, 26 ISSUES.

Nos. 1 to 26.—April 9, 1894, to October 1, 1894. 1 p. each.

WEEKLY WEATHER CROP BULLETIN.—Issued every Monday afternoon during the crop season, 345 reporters representing all of the 96 counties in the State.

F. OF THE PRESS BULLETINS, 10 ISSUES.

No. 57.—January 27, 1894. 1 p.

Articles: No distribution of plants, seeds, etc. The Experiment Station bulletins. Formulas for composts and home-made mixtures for cotton and corn. Soy (soja) beans ought to be planted. *Lathyrus sylvestris*, or flat pea. Advanced meteorological summary for North Carolina—December, 1893. Cold waves. Analyses of fertilizers. Satsuma orange trees. Keeping nitrate of soda. Clover and grass for loamy land; peanuts; chufas. The cultivation of onions and Irish potatoes.

No. 58.—March 29, 1894. 1 p.

Articles: The Experiment Station bulletins. Some late bulletins of the North Carolina Experiment Station. Field peas. Cabbage insects. Advanced monthly summary of meteorological reports for North Carolina—February, 1894. Cotton-seed hull ashes. How to deal with the potato beetle and cabbage worms. Culture of pecans. Proper temperature to churn. Profitable poultry. Grapes and blackberries for market. Benefit of peavines to land. Location for peach orchard. Fireblight of apple tree.

No. 59.—April 25, 1894. 1 p.

Articles: The Experiment Station bulletins. Adulterated cattle food. A good mixture for tobacco. Advanced monthly summary of meteorological reports for North Carolina—March, 1894. Bulky portions of a fertilizer. North Carolina weekly weather crop bulletin. Spraying orchards and vineyards. Dehorning cattle or calves. Blight of tomato and potato. Cultivation of cranberries. Nitrate soda for strawberries. Injury to acid phosphate by marl.

No. 60.—May 3, 1894. 1 p.

Article: Distribution of soy (soja) beans.

No. 61.—May 25, 1894. 1 p.

Articles: Crimson clover for hay or seed. Crimson clover seed distributed in 1893. Experiences with crimson clover. Another fraud exposed. Advanced monthly summary of meteorological reports for North Carolina—April, 1894. Distribution of soy (soja) beans. Directions for cooking soy beans or peas. Chicken cholera and its prevention. Cultivation of barley. Cucumbers for pickles. Shells and lime.

No. 62.—July 27, 1894. 1 p.

Articles: Everbearing mulberries. Three forage plants for sandy soil. Recent bulletins of the North Carolina Experiment Station at Raleigh, N. C. A new potato pest. Raising cabbage for market. Onions. Remedies for borer of peach tree. Grass for permanent pasture. Nitrate of soda, and ashes. Crimson clover, timothy, Bermuda grass.

No. 63.—September 4, 1894. 1 p.

Articles: Curing cow-pea vines. Why pull your corn fodder? Cabbage and its diseases. Advanced monthly summary of meteorological reports in North Carolina for July, 1894. Value of corn and cobs ground together for stock food. Feeding of colts. Cultivation of onions. Lime will injure stable manure. Clover and grass for pasture on sandy soil. Warts upon cows.

No. 64.—September 25, 1894. 1 p.

Articles: Title page changed. The chestnut and its weevil. The army worms. Crimson clover in 1894. The weather in North Carolina during 1893. Self-sucking cows. Advanced summary of meteorological reports for North Carolina—August, 1894. Scuppernongs can be pruned. Bones as fertilizers, and how to utilize them. Hollow-horn and hollow-tail.

No. 65.—October 20, 1894. 1 p.

Articles: Recent bulletins of the Experiment Station. Keeping sweet potatoes through the winter. Advanced monthly summary of meteorological reports for North Carolina—September, 1894. The Russian thistle. Error in report of crimson clover seed yield for 1894. Pea and bean weevils. Ripening tomatoes in winter. Variety of asparagus for planting. To destroy sprouts and stumps. Creamer or separator for southern North Carolina. Bees and bee worms.

No. 66.—November 29, 1894. 1 p.

Articles: Setting out a peach orchard. Value of one day's cow rations as a fertilizer. North Carolina weather during October, 1894. Flowering bulbs in North Carolina. Improve your stock. Rational stock feeding. Tokay grapes. Value of manure. Blue joint grass. Destroying wild onions. Mixing fertilizers at home. Asiatic pears.

G. OF THE ANNUAL REPORTS OF THE STATION, 1 ISSUE.

No. 16.—Report of the Station for 1893. 50 pp.

Letter of transmittal. Officers of Board and Experiment Station. Report of the Director. The fertilizer control station. The Agricultural Experiment Station. Report of the Agriculturist. Report of the First Assistant Chemist. Report of the Botanist and Entomologist. Report of the Horticulturist. Report of the Meteorologist. Financial statement for the year ending June 30, 1893. Appendix.

H. OF THE ANNUAL REPORTS OF THE METEOROLOGICAL DIVISION, 1 ISSUE.

No. 7. Report of the State Weather Service for 1893. 64 pp.

List of Board of Control and officers of the Experiment Station. Publications of the State Weather Service for 1893. Annual meteorological summary, 1893. Collection of meteorological data, and list of meteorological stations and observers during 1893. Weekly weather crop bulletin and list of crop correspondents during 1893. List of stations in North Carolina receiving weather forecasts, cold-wave or frost warnings by telegraph or mail. Comparisons of temperature and precipitation at stations in North Carolina, United States, and in foreign countries. Index.

I. OF THE BIENNIAL REPORTS OF THE STATION, 1 ISSUE.

No. 8.—Biennial Report for 1893 and 1894. 140 pp.

REPORT OF DIRECTOR.

J. OF THE INFORMATION BULLETINS, 5 ISSUES.

No. 1.—November 18, 1893. 1 p.

INQUIRIES AS TO COMPOSTS, HOME-MADE MANURES AND HOME-MIXED FERTILIZERS.

No. 2.—December 16, 1893. 1 p.
INQUIRIES AS TO CARE OF STOCK AND FOOD AND RATIONS GIVEN.

No. 3.—March 30, 1894. 1 p.
INQUIRIES AS TO THE USE OF LIME AND MARL.

No. 4.—April 12, 1894. 1 p.
INQUIRIES CONCERNING CLOVER SEED DISTRIBUTED IN 1893.

No 5.—November 20, 1894. 1 p.
INQUIRIES AS TO SUCCESS WITH SOY BEANS.

Mailing Routes in North Carolina.—In order to facilitate mailing the bulletins, the Station sends the various publications according to the same plan regularly in use in the United States Railway Mail Service. The State is subdivided into mail routes, arranged according to railway lines and convenience in reaching the various offices. Mail-bags are packed for each of these routes, by the Station, and transmission through the Raleigh postoffice and the railway mail service is not delayed. The plan of mailing routes is as follows:

MAILING ROUTES FOR STATION PUBLICATIONS FOR NORTH CAROLINA.

1. Goldsboro and Greensboro, East:
   - Cumberland County.
   - Greene County.
   - Johnston County.
   - Wayne County.
2. Goldsboro and Morehead:
   - Carteret County.
   - Craven County.
   - Jones County.
   - Lenoir County.
   - Pamlico County.
3. Tarboro and Washington:
   - Beaufort County.
4. Newbern and Wilmington:
   - Onslow County.
5. Wilson and Wilmington, South:
   - Brunswick County.
   - Columbus County.
   - New Hanover County.
   - Duplin County.
   - Pender County.
   - Sampson County.
6. Washington & Charleston, North:
   - Edgecombe County.
   - Nash County.
   - Wilson County.
7. Norfolk and Raleigh:
   - Bertie County.
   - Dare County.
   - Franklin County.
   - Gates County.
   - Halifax County.
   - Hertford County.
   - Martin County.
   - Northampton County.
   - Pitt County.
   - Vance County.
   - Warren County.
8. Norfolk and Edenton:
   - Camden County.
   - Currituck County.
   - Chowan County.
   - Hyde County.
   - Pasquotank County.
   - Perquimans County.
   - Tyrrell County.
   - Washington County.
9. Raleigh postoffice:
   - Randolph County.
   - Wake County.
   - Chatham County.
10. Keysville and Raleigh.
    - Granville County.
11. Raleigh and Charlotte:
    - Anson County.
    - Bladen County.
    - Harnett County.
    - Moore County.
    - Montgomery County.
    - Richmond County.
    - Robeson County.
    - Union County.
12. Goldsboro & Greensboro, West:
    - Alamance County.
    - Caswell County.
    - Durham County.

Guilford County.
Orange County.
Person County.
Surry County.
Stokes County.

13. Washington and Charlotte, North:
Rockingham County.

14. Washington and Charlotte, South:
Davidson County.
Davie County.
Rowan County.
Stanly County.

15. Wash. and Char., South—No. 2:
Cabarrus County.
Cleveland County.
Gaston County.
Lincoln County.
Mecklenburg County.
Rutherford County.

16. Greensboro and Wilkesboro:
Ashe County.
Alleghany County.
Forsyth County.
Wilkes County.
Yadkin County.

17. Salisbury and Knoxville.
Buncombe County.
Burke County.
Caldwell County.
Catawba County.
Haywood County.
Iredell County.
McDowell County.
Madison County.
Mitchell County.
Watauga County.
Yancey County.

18. Taylorsville and Charlotte:
Alexander County.

19. Asheville and Columbia:
Polk County.
Transylvania County.
Henderson County.

20. Asheville and Murphy:
Cherokee County.
Clay County.
Graham County.
Jackson County.
Macon County.
Swain County.

The Collection of Special Agricultural Information.

A special publication of the Station has been instituted, designated as the "Information Bulletin," for the express purpose of collecting information from practical farmers upon special agricultural subjects. Many farmers, after years of practical experience, are in possession of certain plans and methods which they have ascertained to be suitable to their needs and surroundings. It is for the purpose of collecting such information, classifying and embodying it in a publication of the Station for the benefit of all alike, that the plan was adopted.

The following is from the prefatory note accompanying a late bulletin:

The well known Hatch Act passed by the United States Congress in 1887, upon the provisions of which the agricultural experiment stations in the various States and Territories depend, contemplated the collection of practical information on agricultural subjects, as well as in disseminating among the people the information thus collected, for the first words of this act, after the enacting clause, read—

"That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, etc.

This Station, therefore, in order to bring together such agricultural information, now widely distributed, and at the same time valuable from the result of constant practice and experience, sends out this Information Bulletin for the purpose of collecting information upon the subject

stated below, and embodying the result in a general bulletin soon to be issued. It is to the interest of all who receive this Information Bulletin, and who have had experience in the special subject below, to write full and complete answers to the questions, for they in turn will be benefited by the general bulletin upon this subject, to be issued as soon as it can be completed.

Up to date there have been five of these bulletins issued:

No. 1. Enquiries as to composts, home-made manures, and home-mixed fertilizers.
No. 2. Enquiries as to care of stock, and food and rations given.
No. 3. Enquiries as to the use of lime and marl.
No. 4. Enquiries concerning success with clover seed distributed.
No. 5. Enquiries as to success with soy beans distributed.

A Conservative and Voluntary Seed Control.

The Station has for some time past been investigating the subject of field and garden seed, and the possible adulterations and impurities that may occur in them. The question of vitality has also received attention. The labor involved in concluding this work, which has been presented in Bulletin 108, has been very great and has extended over several years. The following remarks are extracted from the preface of that bulletin:

The question of good seed for planting is known to be a most important one. While there are many well-established seed houses who would not knowingly deceive in placing their goods on the market, yet it is certain that there are others who are not so scrupulous, who sell bad and adulterated seed either through ignorance or design. Evidence upon this point is too strong to admit of a doubt. Even the conscientious seedsmen may be liable to buy adulterated seed and sell them to others without knowing their true character.

Seed testing is of value both to seedsmen and to purchasers. To seedsmen, on the one hand, in enabling them to understand the real nature of the material they buy before selling to others; to buyers, on the other hand, to enable them to know if the seed they propose planting are vital seed and free from every objectionable weed adulteration.

An official seed control may be open to many objections, and might not be advisable at this time. A voluntary seed control does not possess the objectionable features of a legal enactment, and it may prove to be a satisfactory solution to the present difficulty. Such a control is managed without the enaction of law. It is inaugurated by means of the voluntary co-operation of both sellers and buyers, and is gov-

erned by the laws of trade and mutual benefit. The fundamental principles upon which such a control is based is the progressive spirit of seedsmen who agree to sell living seed of certain stated percentages of vitality, and free from adulterations. If, after testing, it is found that the seed does not reach this quality, or contains any adulterations, the seedsmen agree to take back the seed, paying transportation charges each way, or else refund a proportional part of the cost of the seed; no claim for damages to extend beyond thirty days, or after the seed is sown. The guarantee is only a guarantee that the seed is what is claimed for it, and does not extend to the quality of the crop. Evidently there are too many conditions affecting the growth of the seed in the soil for any guarantee to be given as to the yield. Bad preparation of the land, too deep or too thin covering of the seed, bad weather conditions, are some of the most common conditions injuriously affecting growth of crops, and for these the seedsman is certainly not responsible.

Competition is the soul of trade, but fair competition is possible only when competing goods are sold upon their real merits, as must be the case when seed are sold under a definite guarantee based upon a standard method of scientific analysis. If some enterprising dealers, knowing thoroughly the quality of seed they sell, voluntarily state that the goods are what they claim, and subject to the above guarantee, then it will not be strange if they should commence to handle the bulk of the trade. Purchasers undoubtedly will buy where they can get the best seed for the money.

The whole matter may be left now with an enlightened and discriminating public.

The Insect Fauna of North Carolina.

The State has never had a systematic investigation of the insect life within her borders. Such a survey, conducted *de novo* in the usual manner of such surveys, would be very costly and would consume much time. A plan, however, is in contemplation, which is outlined below, by which the expense would be reduced to a minimum, and an additional beneficial result would accrue from the investigation. The plan contemplates co-operation with the public schools of the State, and the collection by their pupils of insect specimens in their immediate locality. The various sections would thus be thoroughly investigated, and collections embracing all parts of the State would be brought together. A

bulletin detailing the systematic classification of insects has already been prepared for the purpose of being used in the proposed collections. This bulletin has special reference to ordinary insects and insects injurious to crops. The reasons that governed the preparation of it are:

First, in order that the people of the State should have the means of studying and understanding the numerous insects, both foes and friends, constantly noted on every side. It is evident that this can be done to better advantage if the structure, classification, and life history are known in connection with a knowledge of a particular specimen when it is being studied. *Second*, to extend a spirit of investigation and study among the children of the State, both at their schools and at home. It is expected that this will be accomplished by creating an interest in the collection of insects, and their preservation for permanent interest and value. In this way, if the activity of the children is aroused, it will undoubtedly extend to the parents, and to both will result a better knowledge of insects and methods designed to destroy them. Many simple remedies can be applied that would save many crops to their owners if only these remedies were known. To aid in the creation of interest in the study of insects, the preservation of beneficial species, and the destruction of noxious ones, it is probable that the Experiment Station will offer cash prizes for the most meritorious collections of insects collected and named according to the classification of the present bulletin. The offer will doubtless be made only to the public schools of the State and their pupils. *Third*, to increase our own knowledge of the insect fauna living in the borders of the State, and in this study collections carefully made as above described and procured from all parts of the State will be invaluable. The flora of North Carolina has been studied widely, and is among the richest and best known in the world. In fact, the name *Caroliniana* appears as a part of the specific name of plants more frequently than that of any other State. This is doubtless due to the researches of two of her citizens of world-wide reputation, Dr. L. D. von Schweinitz, of Salem, and Dr. M. A. Curtis, of Wilmington, and of Michaux, the elder and younger, and other European botanists, who did most of their collecting in North Carolina. The flora of the State embraces some six thousand distinct species, due to the varied elevations within her borders and the consequent diversification of climate. As there is such close connection and mutual dependence between plants and insects, it is doubtless

the fact that there is relatively as large insect fauna within the State, and as interesting as the flora. No such attempt has ever been made to systematically study our insect life. It is desirable that a beginning should be made, and collections from different portions of the State carefully made by the various schools would be of great assistance in the work. At the same time, collections made in this way would tend to increase the interest of school pupils in natural sciences, would teach them the value of observation of the life and events around them, and which, in addition, would be of marked value to them in after-life as agriculturists. This interest would doubtless extend to their parents, who would in turn derive benefit from their labors.

The Dairy Industry.

Recognizing the need of some change from the one-crop system so largely used in the cultivation of tobacco and cotton, the Station has endeavored to give special encouragement to the dairy interest in North Carolina. Milk, butter and calves are safe money crops that do not exhaust the land. Home-made fertilizers can be made, and thus a saving in the purchase of commercial fertilizers is affected; and such a system compels the use of best breeds, whose increase are also of particular value. No less than eleven separate bulletins have been issued, in editions of many thousands each, which gave special assistance in the care and feeding of stock, building of silos, and to the encouragement of the dairy industry.

While there is room for very great improvement for the future, still our State has added to the dairy industry and the care of improved stock much more in the past decade than is generally supposed. As summaries of these improvements, the following statement is offered, based on official figures of the tenth and eleventh censuses:

1st. That North Carolina has increased her farming capacity twenty per cent. during the ten years preceding 1890.

2d. That North Carolina has discarded thousands of comparatively worthless milch cows and other stock.

3d. That North Carolina has introduced better breeds of dairy and other stock, and has made other improvements dependent upon this fact.

4th. That North Carolina has increased the number of her improved milch cows, in proportion to the number of her

improved acres, more than any other State, with the exception of Florida.

5th. The the total yield of milk, butter and cheese in North Carolina shows very great increase as the result of improved stock.

6th. That the average yield per cow in North Carolina has increased during the ten years previous to 1890 far greater than has been the case in most of the other States, and the actual yield is better than most of the Southern States.

7th. That the number of butter factories in North Carolina are increasing, and it is likely this result will prove as advantageous here as has been the case in the older dairy states.

These encouraging results are due—

1st. To the changing conditions in the agriculture of the State, which demand that home supplies be first made; and next, that money crops be undertaken as far as they can economically be produced.

2d. To the adoption of the "no-fence" laws in almost every one of the middle and eastern counties.

3d. To the encouragement and assistance afforded by the Station and other organizations, agricultural journals, and enterprising individuals.

4th. To the awakening of the people of the State to the benefits derived from the discriminating care of improved stock, and other advantages following in its train.

Should our people be content with what has been done? There is need for greater improvement. Instead of having but little over one per cent. of the milch cows of the United States within our borders, and producing about one per cent. of the milk of the United States, North Carolina ought to have at least five per cent., both of the number of cows and production of milk, by the year 1900; and with this increase the State would show corresponding improvements in all agricultural industries. And there is no reason why this should not be.

The Marls and Phosphates of North Carolina.

The work of the Experiment Station, from the earliest period of its existence, has embraced the chemical examination of natural deposits that might be used for agricultural purposes, as well as other materials that could be so utilized from the by-products of other industries, or those that could be saved and used by careful management on the farm. The

Station has thus been of material assistance in giving a more definite idea of the value of such materials, as well as advice to those who were, perhaps, unconscious of their proper use.

Since the establishment of the Station, in March, 1877, many hundreds of analyses of marls and phosphates have been made. These are collected in a special bulletin (110), and such information of the location and extent of the deposits as could be gathered from our records is also inserted. A description of the geological features of the formations, together with their distribution, varieties and uses, are included. A chapter on the manufacture of acid phosphate from mineral phosphates is also appended in order to give a more perfect idea of this very important material.

Veterinary Investigations.

For some time the Station has desired to have the services of a competent veterinarian upon its staff, but owing to lack of funds it has been unable to do so. Temporary arrangements have, however, been entered into with F. P. Williamson, D. V. S., as Consulting Veterinarian to the Station, and up to date one educational bulletin has been issued, and such veterinary work has been completed as was required in the progress of the feeding and digestion work in the agricultural division. Further detailed statements can be seen by reference to the work of the veterinary division.

Some Adulterations Detected.

During the year two notable adulterations have been detected and brought to light. The first of these was adulterated wheat bran. This stock food is purchased largely from the west, and, judging from the following examination, it would seem that it is being deliberately adulterated. Of wheat bran purchased on the Raleigh market, a one-pound sample was drawn and examined and found to contain 10.96 per cent. of the following: unground kernels of wheat, oats, cockle, chess or cheat, and several other varieties of weed seeds. Some of the light wheat seed were, in addition, affected with burnt or stinking smut (*pucinia rubigovera*). The cockle seed (*lychnis githago*) was present to the amount of 2.77 per cent., or 55.4 pounds per ton, and the chess or cheat (*bromus secalinus*) was present to the amount of 1.01 per cent. of the whole, or 20.2 pounds per ton. The stock at the Station would have consumed about 2¼ tons per month

(at the rate then being fed), and a monthly saving of fifteen tons of stable manure could be secured. Feeding this adulterated bran, the manure from it, after many of the whole weed seeds had passed through the animals, would be amply sufficient to seed any ordinary field with very objectionable weeds, to the great detriment of the growing crop. This result would easily offer one explanation to the vexed question of "Can wheat turn to cheat?"

The other adulteration detected was the sale by a traveling party of cabbage seed, "recommended by the United States Agricultural Department as the best for the Southern States," "grown and warranted by the Junaluska Seed Company, Junaluska, N. C." The seed was worthless, and consisted in the main of European wild cabbage. Both the name of the post-office and the seed firm were fictitious, and the whole transaction was fraudulent. It was ascertained that the same people had previously sold similar seed under the title of the Reems Creek Company. Publication was at once made of the circumstances, and it is hoped that future transactions can be avoided.

The Importance of Rational Stock Feeding.

The subject of stock feeding is of such importance that the Experiment Station continues to call attention to it, not only in conducting experiments to determine the digestibility of various common foods in daily use, but also in distributing information designed to be of immediate value to the stock feeder.

There are in North Carolina, according to the latest returns (State Auditor's Report of 1894)—

Horses	146,725,	valued at	$7,497,225
Mules	111,463,	"	6 475,251
Cattle	624 716,	"	4,806 663
Hogs	1,136,256,	"	1,620,117
Sheep and Goats	396,564,	"	390,168
Total	2,415,724,	"	$20,789,424

Assuming that the very small sum of fifteen cents per month for each head could be saved by more careful feeding, there would be saved to the people of the State over four millions of dollars annually, a sum approximating nearly one-sixtieth of the total assessed real and personal property of the whole State.

All stock feeds are not the same in quality. Some are richer in some ingredients than others. These ingredients, when eaten in food, act differently in building up the body. Some make flesh; some make bone; some make heat and force. Foods, therefore, vary greatly in value for different purposes. Again, the constituents may not wholly be available to the animal. A portion of a certain constituent may be easily digested, while the other part may pass entirely through and go off as waste. If the manure is not preserved it is really an absolute waste. The digestible portions of the various constituents must be determined by actual feeding tests with animals, while the constituents must be carefully analyzed, chemically. By actual feeding it has been ascertained what quantity of these digestible constituents is needed for different purposes of feeding to produce fat, or growth, or sustain vigor when worked. In this way we can lay down a rule for feeding animals, and, knowing the foods we have at hand, and the digestible proportions, it will be easy to combine them according to the best advantage.

Of such importance is the subject considered, that two bulletins have been issued within the past two years touching specially upon the rational and practical feeding of stock. These are in addition to the result of experiments upon the digestion of various common stock foods, which are included in separate publications. The last of these bulletins (106) contains also detailed results of correspondence with leading stock feeders and breeders, in which different feeding rations are given and discussed.

The people of the State, in order to make money, must save it, and to accomplish this no better way can be suggested for immediate trial than more careful feeding of their stock. To this end a thorough understanding of the principles underlying it is essential. Our people must weigh their stock foods and mix them in the right proportions if they desire to stop a tremendous leak in farm economy.

Means for Reaching Farmers.

As the main plan for carrying before the farmers the work and results reached at the Station, the bulletins are foremost. It is one thing to conduct agricultural investigations designed to benefit farmers and others and to reach important results. Accurate and painstaking care are essential, combined with the requisite skill and experience. Without these the results, when reached, are inaccurate and misleading.

After important and valuable results are secured, it is entirely a different matter to bring these results before the attention of those for whom they were particularly designed to benefit. This phase of the question has been especially considered, and various methods have been pursued to arrive at the best result. The usual bulletins of the Station are intended, in a great measure, to supply this demand, and they have been prepared so as to reach the plain, matter-of-fact farmer, who has little inclination to study difficult tables and abstruse discussions. At the same time the technical and scientific work and results are not lost sight of, but are distributed in the technical series to persons particularly interested in them. The popular bulletins, containing summaries of important results, as well as the educational series of bulletins, have accomplished most beneficial results by their widespread distribution. There appeared to be, however, an important link in the dissemination of information of the work and results of the Station which was not yet filled. This, however, by the adoption of the press bulletin, was corrected, and short, concise articles upon these subjects were thus distributed and found their way in newspaper columns, increasing their circulation many fold. The additional plan of sending out plate-matter containing these articles still largely increased the circulation and reached the attention of thousands that did not before have the opportunity of considering the Station's work.

Much has been done also through direct correspondence with farmers, and their queries have included every branch of farming and kindred pursuits. Each division of the Station conducts its own correspondence, and all queries sent in are referred to the appropriate division most able to give the fullest and best answer. These questions and replies, when of sufficient public interest, are printed and distributed by means of the press service plate-matter. The members of the Station staff also, whenever practicable, visit farms, farmers and their meetings, attend farmers' institutes and deliver talks and addresses, as well as write for agricultural newspapers and journals.

It is confidently believed that never before in its history has the Station done so complete and acceptable work as now, and that the people of the State are far more alive to take advantage of the offers of assistance by the Station, and to benefit themselves by its results.

Acknowledgments.

The Station takes pleasure in acknowledging the receipt during 1894 of the books and pamphlets, journals and newspapers stated below. The reports and bulletins of the U. S. Department of Agriculture, and of the various Experiment Stations in the different States and Canada are not included in the list, but are regularly received.

BOOKS AND PAMPHLETS.

Indiana Dairy Association, Indianapolis. Report for 1893.
Brown University, Providence, R. I. Report for 1893.
Auditor of North Carolina, Raleigh. Report for 1893.
Georgia Department of Agriculture, Atlanta. Publications for 1893.
New York Entomologist, Albany. Reports for 1891 and 1892.
Pennsylvania Board of Agriculture, Harrisburg. Analyses of Fertilizers, 1893.
W. Atlee Burpee & Co., Philadelphia. Injurious Insects.
Oregon Board of Agriculture, Portland. Bulletin No. 8.
German Kali Works, New York city. Praktische Dungtafel.
New York Dairy Commission, Albany. Report for 1892.
University of Pennsylvania, Philadelphia. Contributions from Botanical Laboratory.
North Carolina Geological Survey, Chapel Hill. Bulletin No. 1—Iron Ores.
Massachusetts Board of Agriculture, Boston. Horticulture of Massachusetts.
Royal Agricultural Society, England. Journal of Society; vol. 5, part 1.
Prof. T. Jamieson, Aberdeen, Scotland. Proceedings of Agricultural Research Association.
Maryland Agricultural College, College Park. Report for 1893.
Ontario Agricultural College, Guelph. Report for 1893.
Smithsonian Institution, Washington. Scientific Results of the Expedition to West Africa.
North Carolina Bureau of Labor Statistics, Raleigh. Report for 1893.
Elisha Mitchell Scientific Society, Chapel Hill, Journal of Society, 1893; part 1.
North Dakota Department of Agriculture and Labor, Fargo. Russian Thistle in the Northwest.
Smithsonian Institution, Washington. Bulletin No. 43 of U. S. National Museum.
Hon. P. de Murguiondo, Baltimore. Maps of Uruguay.
U. S. Department of Agriculture, Washington. Contributions of National Herbarium.
Missouri Botanical Garden, St. Louis. Report for 1893.
Sir J. B. Lawes, Rothamsted, England. Results of Field and Other Experiments at Rothamsted.
Hebrew Technical Institute, New York city. Report for 1893.
University of Michigan. Plants of Lake St. Clair.
American Museum of Natural History, New York city. Report of President, 1893.
Purdue University, Lafayette, Ind. Special Bulletin on Fertilizers.
Purdue University, Lafayette, Ind. Annual Register.
University of Virginia, Charlottesville. Catalogue of University.
Missouri Horticultural Society. Report for 1893.
U. S. Geological Survey, Washington. 12th Annual Report.

New York City Board of Health. Report for 1892.

F. W. Hawley, Pittsford, N. Y. "Pittsford Farms."

Society of Natural History, Cincinnati, Ohio. Journal of Society, No. 1, 1894.

North Carolina Normal and Industrial School, Greensboro. Catalogue, 1893.

Department of Interior, Washington. Part 2, Eleventh Census.

American Philosophical Society, Philadelphia, Proceedings of Society, June, 1894.

U. S. Weather Bureau, Washington. Weather Chart.

Connecticut Board of Agriculture, Hartford. Report for 1893.

Washington University, St. Louis, Mo. Catalogue of University.

Michigan State Board of Health, Lansing. Report for 1891, and Addresses at Sanitary Convention.

Ohio Wesleyan University, Delaware, Ohio. Catalogue 1893-'94.

Ontario Department of Agriculture, Toronto. Report of Bureau of Industries, 1892.

Massachusetts Horticultural Society, Boston. Transactions of Society; part 2; 1893.

U. S. Geological Survey, Washington. Publications of Survey.

Ontario Department of Agriculture, Toronto. Report for 1893; vol. 1 and 2.

Kansas Board of Agriculture, Topeka. Feeding Wheat to Farm Animals.

Indiana Academy of Science, Brookville. Proceedings of 1893.

Tennessee Department of Agriculture, Nashville. Medicinal Plants of Tennessee.

Royal Agricultural Society of England, London. Journal of Society.

American Berkshire Association, Springfield, Ills. Year Book; 1894.

James H. Enniss, Raleigh, N. C. Turner's Almanac; 1895.

T. L. Blalock, Baltimore, Md. Pamphlet on "Instruments for the Graduation and Calibration of Volumetric Apparatus."

Massachusetts Horticultural Society, Boston. Transactions of Society; part 1; 1894.

Society of Natural History, Cincinnati, Ohio. Journal of Society, No. 3; 1894.

U. S. Department of Agriculture, Washington. Report of Secretary of Agriculture; 1893.

Kansas Board of Agriculture, Topeka. Report on Alfalfa.

S. M. Tracy, Agricultural College, Miss. Address on "Industrial Knowledge," by Dr. S. A. Knapp.

Virginia Board of Agriculture, Richmond. Report for 1894.

Alabama Department of Agriculture, Montgomery. Address on "History of Cotton," by H. D. Lane, Commissioner of Agriculture.

Royal Agricultural Society, England. Journal of Society; vol. 5, parts 2 and 3.

JOURNALS AND NEWSPAPERS.

Agricultural Epitomist	Indianapolis, Ind.
Agricultural Gazette of New South Wales	Sydney, Australia.
American Agriculturist	New York, N. Y.
American Dairyman	New York, N. Y.
American Farmer	Washington, D. C.
American Grange Bulletin and Scientific Farmer	Cincinnati, Ohio.
Baltimore Sun	Baltimore, Md.
California Cultivator and Poultry Keeper	Los Angeles, Cal.
Clover Leaf	South Bend, Ind.
Cotton Plant	Columbia, S. C.
Elgin Dairy Report	Elgin, Ill.
Farm Journal	Philadelphia, Pa.

Farmers' Advocate	Burlington, Vt.
Farmers' Advocate	London, Ontario.
Farmers' Home	Dayton, Ohio.
Farmers' Magazine	Springfield, Ills.
Farm and Dairy	Ames, Iowa.
Farm and Home	Springfield, Mass.
Farm and Fireside	Springfield, O.
Florida Farm and Fruit Grower	Jacksonville, Fla.
Grange Visitor	Charlotte, Mich.
Hoard's Dairyman	Ft. Atkinson, Wis.
Home and Farm	Louisville, Ky.
Homestead	Des Moines, Iowa.
Hospodar	Omaha, Nebraska.
Industrial American	Lexington, Ky.
Journal American Philosophical Society	Philadelphia, Pa,
Louisiana Planter	New Orleans, La.
Mirror and Farmer	Manchester, N. H.
National Dairyman and Messenger	Kansas City. Mo.
National Stockman and Farmer	Pittsburg, Pa.
Ohio Farmer	Cleveland, Ohio.
Peninsular Farmer	Federalsburg, Md.
Practical Farmer	Philadelphia, Pa.
Progressive South	Richmond, Va.
Southern Cultivator	Atlanta, Ga.
Southern States Magazine	Baltimore, Md.
Sugar Beet	Philadelphia, Pa.
Trade Journal	Baltimore, Md.
Weekly Times	Melbourne, Australia.

Alamance Gleaner.
Asheville Citizen.
Burlington News.
Beaufort Herald.
Carthage Herald.
Caswell News.
Caucasian.
Central Times (Dunn).
Charlotte Democrat.
Charlotte Observer.
Chatham Record.
Concord Standard.
Concord Times.
Davie Times.
Durham Sun.
Economist-Falcon.
Eastern Reflector.
Elizabeth City News.
Franklin Press.
Free Press (Kinston).
Greensboro Patriot.
Headlight (Goldsboro).
Henderson Gold Leaf.
Hendersonville Times.
Martin County Sun.
Mecklenburg Times.
Messenger and Intelligencer.
Monroe Enquirer.
Monroe Journal.
Morganton Herald.
Murphy Index.
North Carolinian (Raleigh).
N. C. Baptist (Fayetteville).
Patron and Gleaner (Lasker).
Press and Carolinian (Hickory).
Progressive Age (Aurora).
Progressive Farmer.
Public Ledger (Oxford).
Roanoke News, Weldon.
Robesonian (Lumberton).
Salisbury Watchman.
Stanly News.
Star of Columbus (Vineland).
Statesville Landmark.
Shelby Review.
Tarboro Southerner.
Tar Heel Poultryman (Shelby).
Union Republican (Winston).
Warrenton Record.
Washington Progress.
Washington Gazette.
Waynesville Courier.
Webster's Weekly (Reidsville).
Western Sentinel (Winston).
Wilkesboro Chronicle.
Wilmington Messenger.
Wilson Mirror.

Bulletin North Carolina Board of Health, Raleigh.
North Carolina Medical Journal, Wilmington.

The Work of the Agricultural Division.

Much of the attention of the division has been devoted to digestion work with cattle to determine the true value of common feeding stuffs. A bulletin has been issued giving the result of feeding steers, tied-up in narrow stanchions, and loose in roomy stalls; also feeding of native and grade steers for beef, and two-year-old and three-year-old steers for beef.

In the dairy another year's record with the milk and butter produced, in comparison with the amount fed, is complete and is of much interest.

The division prepared during 1894, in connection with the chemical division, a bulletin (97) of 48 pages, and, in conjunction with the botanical division, a bulletin (98) on "Some Leguminous Plants and their Economic Value" was issued. This last was the result of detailed experiments with these plants, and written in a popular style for home reading. In the line of encouragement to the dairy industry of the State, a bulletin (102) was prepared, with 12 pages, giving the result of the tests of the dairy cows at the State Fair, for which liberal premiums had been offered. The question of the advisability of pulling corn fodder received attention, and a short bulletin (104) was issued, calling attention to the loss in nutritive matter by the plan of pulling fodder, coupled with the high cost of the same, as well as the saving which might be effected by cutting and curing the whole stalk. In connection with the chemical division a popular bulletin (106) of 44 pages was issued upon the subject of "Rational Stock Feeding," including definition of terms, and composition and digestibility of foods, feeding rations, how stock rations can be calculated, some rations fed in North Carolina as determined by correspondence through the information bulletin, and comments of practical stock feeders and breeders; also some particular rations suggested. The result of feeding trials with animals pursued during the year 1894 has been recorded in another bulletin (109), and includes the effect of cotton-seed hulls and meal as cattle foods, cotton-seed meal for horses, pigs and calves, the effect of feeding skimmed milk to lambs, and a system of feeding young calves, together with a pig-feeding test. It was shown in this work that cotton-seed meal was an unsafe food for calves and pigs, though for horses, cows and beeves, when fed judiciously with other foods, it gave excellent results. It has also been determined in the digestion work already referred to, that cotton-seed

meal with coarse nitrogenous fodders increased materially the digestibility of those fodders.

In field crops special efforts have been made to extend the cultivation of crimson clover and soy beans, and seed have been distributed to various sections of the State. The plan of planting soy beans with corn in alternate hills, and ensilaging both together, has been successful, and gives a more complete food than corn silage alone. The Wonderful or Unknown variety of cow pea has proven the best variety for the production of forage, though it is later than most varieties. A yield at the rate of 15.67 tons of green forage per acre has been made, which, when cured, weighed at the rate of 5.8 tons per acre.

A breeding test of sheep is in progress, and Dorset-Horn, Merino, Southdown, and Hampshire crosses on native ewes will be made, with the view of breeding up common stock.

Special dairy implements and machinery have been tested, and the results, together with the yield of milk and butter from the stock at the farm, are ready for a forthcoming bulletin.

The Work of the Chemical Division.

The work is divided into fertilizer analyses for the fertilizer control, miscellaneous, and experimental. A large proportion of the analytical work has been in the fertilizer control. This involves very careful and detailed chemical work. Each sample of fertilizer is received from one of the official inspectors in a glass jar and sealed air-tight. It contains a metallic tag, on which is a number to correspond with the register of the inspector. Not until the analysis is finished is the name of the brand known as represented by the sample. The sample is carefully prepared for analysis, and six separate and distinct chemical determinations are made on each ordinary fertilizer before the analysis is concluded, after which the clerical calculations are carefully checked to prevent error.

In addition to commercial fertilizers, many analyses have been made of fertilizing material, both natural and commercial, when sent in by farmers and others. These include marls, phosphates, mucks, wastes, composts, etc., as well as miscellaneous fertilizing chemicals. Some analyses of waters, ores, etc., have also been made. Many analyses of native forage plants and foods have been made; also analyses of milk. The division has co-operated with the agricultural

division, in the conduct of digestion work, to determine the value of various common stock foods, alone and in combination, as well as in a study to investigate the presence of important chemical constituents in these foods and their products. In addition, much time is consumed in the studies of chemical methods and the elucidation of chemical questions involved in the fertilizer work.

During 1893, 751 separate samples were completed. About one-third of these are included under the head of fertilizers, and one-third each under the heads of miscellaneous and experimental. During 1894 there have been 741 separate samples of all characters completed. During the two years ending December 31, 1894, samples have been completed embracing 606 commercial fertilizers, 46 fertilizing materials, 27 marls and phosphates, 13 soils, 16 samples for fertilizer methods, 51 milk, cream and butter, 220 waters (including mineral and health), 106 fodder analyses of foods and feeding stuffs in the digestion work, 34 urines in digestion work, 11 fertilizer analyses in fodders, 92 tobaccos, 60 nitrate experiments, 172 minerals identified, and 38 miscellaneous samples.

The work done in connection with the agricultural division and recorded in bulletins has already been referred to. The digestion work with cattle foods, concluded during the year 1894, has been more complete than ever before, in that urine has been analyzed, in addition to other feces, to ascertain the fertilizing ingredients contained therein.

An interesting experiment has been made to ascertain the effect of using nitrate soda in mixed fertilizers, and whether there resulted any loss of nitrogen from the combination. The chemical work in tobacco, to include every variety produced in the United States, has been continued, and the result is about ready for publication.

The Work of the Botanical and Entomological Divisions

The work in these divisions embraces, among other subjects, the identification of grasses or insects sent in by farmers and others in order to determine their value, if any, or otherwise to learn how to destroy them, if injurious. The diseases of cultivated crops, vines and fruit trees receive attention; and different fungicides and insecticides, as well as spraying apparatus and methods of trapping or destroying noxious insects, all have been studied, and in the past several general bulletins have been issued upon the subject.

The botanical division has, with the agricultural division, tested varieties of grasses, clovers and leguminous crops. The result of the last has already been published in bulletin 98, which also includes a chapter on fungous diseases and insect enemies. The result of the test with grasses is nearly ready for publication, as a companion bulletin to that on leguminous crops. It will also be written in a popular style for general distribution, and will include chapters on the cutting and curing of hay, and the care of meadows and pastures.

The work on seed testing, to determine the nature and extent of the various seed adulterations and the requisite vitality and purity of commercial seeds, including field, garden and flower seeds, is about brought to a close. The work has extended over several years of careful research, embodying all sources of information in this country and abroad, as well as careful and detailed examination of many hundreds of samples and seeds from many sections. The result of the research has been embodied in bulletin 108 of seventy-six pages and containing forty-four cuts. A voluntary seed control is suggested as being probably the best solution of the question, which is elaborated in this bulletin. A standard of quality and vitality for seeds is also given as the result of the work.

Plans are on foot for the preparation of a complete work on the medicinal plants of North Carolina. This State leads all others, and doubtless the world, in the variety and nature of the wild medicinal plants, and some authentic investigation and publication would be of great advantage in describing these natural advantages, and possible plans for improving them, as well as in better utilizing them.

A bulletin (105) of twelve pages, on the weevil of the chestnut, has been issued, giving a life history of the insect, as well as the best plan of treatment of these nuts to place them in the best marketable condition. A similar publication, upon the insects and fungi affecting forest trees, is in preparation. A bulletin (100), on the popular classification of insects, has been prepared, containing thirty-six pages, and illustrated with sixty-four cuts. This has been done in order to increase the general knowledge upon the subject, not only among farmers but among their children, which will be of material aid to them in after life.

The Work of the Horticultural Division.

Variety tests of vegetables have not generally been conducted on the Station farm because of the lack of suitable land. Methods of cultivation, and a study of new crops, and developing better varieties from cross-fertilization, have received attention in preference to variety tests.

Bulletin 107, already issued on commercial bulb culture, not only gives in detail plans for their propagation, but illustrates the appearance of the bulbs grown at the Station by drawings from nature. These bulbs described included amaryllis, freesias, gladioli, hyacinths, lilies, tuberoses, and tulips.

There is in preparation a bulletin on trucking crops which will shortly be issued. The plan for protecting grapevines with a board coping is shown to be successful in preventing black rot, but it harbors insects to such an extent that the plan will be abandoned. Preparation was made in 1894 to treat the tomato blight with Bordeaux mixture, but the disease did not appear on the ground, which had not grown the tomatoes before. Tests were conducted with hop cuttings obtained from New York State, but the growth was small the first year. The second year will show larger growth. Sweet potatoes have been grown from the seed obtained from Florida, and the small tubers saved will be used for planting the next season. Next year the cross-breeding of seedlings of blackberries and raspberries will be undertaken. Owing to the extreme cold of last spring, the hybrid grapes from Texas were much hurt, but some of them made almost phenomenal growth. This is also the case with the foreign grapes under glass.

The Work of the Meteorological Division.

This division embraces the State Weather Service operating in conjunction with the Weather Bureau of the United States Department of Agriculture. Two members of this bureau are now stationed here, and the Station is at no expense for their maintenance. All the benefits, consequently, of the State Weather Service are secured to the Station and the State merely at the expense of the printing of the publications of the Service. The Service collects meteorological data from different parts of the State, and records and publishes the results in order to extend information in regard to our matchless climate, as well as to obtain

a more perfect idea of the climatic conditions in different sections. Thus will it be possible to locate the best habitat for such other plants and crops as it may be desirable to introduce. Telegrams (correct in nearly eighty-five per cent. of the predictions) are distributed to various portions of the State, giving the probable state of the weather for the succeeding thirty-six hours. There are also distributed in the same way warnings of the approach of frosts, storms, floods, and cold waves, thus protecting field and trucking crops, the tobacco and fruit interests. Reports are also collected showing the effect of the weather upon the crops during successive periods of their growth. The Service has steadily grown in favor, and its usefulness and material value are very generally being recognized.

In collecting the meteorological data, seventy-three observing stations are utilized, of which number fifty-two are conducted by voluntary effort on the part of public spirited citizens, the remainder (twenty one) are either regular or temporary observers of the weather bureau. During 1894 seven stations were established and three more will shortly be added. Two have been discontinued. These reports make up the monthly meteorological bulletin, which is quite complete in the data recorded and the comparisons made in former years. The monthly issues are utilized in the preparation of the annual reports, the last of which (the seventh annual for 1893) contains sixty-three pages.

In the preparation of the weekly weather crop bulletin, twenty-six numbers of which were issued during 1894, there were 350 reporters from every one of the ninety-six counties. This report is much appreciated at home and abroad. Advantage was taken of the notice of insect depredations mentioned in these reports to send to the one reporting them, directions how to prevent their ravages.

The weather forecasts are now distributed to various points for displaying signal flags and bulletins, and thus disseminate more quickly the information. Fifty-five regular stations receive the information by telegraph, and sixty-seven special stations for frost warnings, cold wave, and storm warnings are also reached. These numbers will probably be soon increased. Three hundred and twenty-three additional offices are reached by mail.

The Work of the Veterinary Division.

Since this division was organized, it has co-operated with the agricultural division in different ways during the progress of various lines of work in the post-mortem examination of several animals that have died under suspicious circumstances, and in applying the new test of tuberculin to the whole Station herd. One general bulletin (99) has been prepared on the thread worm of pork (trichina spiralis), in which its life history is given, how it gets into the flesh of pork, and how it can be avoided.

Reports of the Various Divisions.

The reports of the heads of the various divisions will be found appended.

REPORT OF THE AGRICULTURIST.

DR. H. B. BATTLE, *Director:*

SIR: The work of the Agricultural Division has been steadily developed in the lines previously reported. Several bulletins have been prepared and data has been accumulating for others. These have been chiefly in the line of forage crops, feeding stock, and in dairy work. In animal digestion, another season's work has been added to what has previously been reported, and in the same line of investigation. The digestion of rations of cotton-seed hulls and meal have continued to receive attention until we have become convinced that the combination of highly nitrogenous by-fodder with coarse fodders not only causes the albuminoid part to make the ration productive in some kind of work, but enables the animal to digest more from the coarse food than when the latter is fed alone. How else can be explained the successive gains in percentages of rations digested, when ratios are narrowed? So far appearances indicate that the ratios actually digested are wider than is shown by calculation in rations "balanced" according to common usage with by-fodders. This appears to be due to considerable increase in the digestibility of the non-nitrogenous group, coupled with some decrease in the digestibility of the protein group. This is not new. It seems, however, sufficient to warn against putting entire dependence upon calculated rations where rich by-fodders are used to balance them. Rations of cotton-seed hulls and meal, or corn silage and cotton-seed meal can now be calculated with coefficients of digestibility obtained from actual digestion of rations in several desirable proportions. If similar combinations of other foods vary as much as these do, why could not a few wide and narrow combinations be determined, and rates of variation be established, then interpolate others with greater accuracy than can be attained by the present method. Although we may doubt the entire accuracy of the present method, it is of the greatest practical service in making rational combinations of food for animals. In this line, we rather prefer that feeders should make the application of the method and figure out their own

combinations, rather than to suggest rations which may not be entirely applicable to their needs. Hence, Bulletin No. 106, on "Practical Stock Feeding," has been designed to place all the reliable data possible in the hands of feeders, with plain directions for their use. As an aid in the work, Information Bulletion No. 2, containing inquiries as to the care and feed of stock, was distributed, and replies in regard to cattle, sheep, swine, and horses, from over two hundred leading stock owners and feeders was the result of this request. A few rations which were reported to us are included in Bulletin No. 106. The comments on these serve to show wherein some excel and others are faulty.

They also point to the methods of correction. The few pages condensed from only a few of the reports show that stock-raising and economical methods of feeding and handling are receiving the active attention of a considerable number of intelligent men. The influence of this activity in live stock must soon be felt as a leaven in the agriculture of the State.

In our efforts to aid this movement the following bulletins have been prepared during the year: By co-operation with the botanical division, Bulletin No. 98, for which data has been collected for several years past. Bulletin No. 102 is a record of tests of cows made at the State Fair in 1893 and the proposed tests for 1894. The result of the 1894 tests were highly satisfactory, but have yet only been published for local distribution, showing to whom premiums were awarded, based upon the highest number of points earned by the cows entered in the test. No premium was offered for the first test, but in 1894 the State Agricultural Society offered liberal premiums. Other published work with stock (Bulletin 109) has been in the experiments in pig feeding with separated milk and on several rations differently prepared, and in calf feeding with cotton-seed meal, and feeding cotton-seed meal to horses, pigs and calves.

With Dr. Williamson, Consulting Veterinarian to the Station, some work has been done with tuberculin in the search for tuberculosis in the Station herd. Several *post mortem* examinations have also been held on animals that have died from other causes. These either have been reported in bulletins now in press, or will be so reported soon.

The loss of our short-horn bull, slaughtered because of the adverse finding by the tuberculin test, has, with other obstacles, lost us the results expected from coupling the strain of short-horn blood represented by this animal with our native,

grade, and cross-bred dairy cows. We still believe that for a large number of breeders of native stock this is the first step in improvement to be made for best results. We were unfortunate in one respect as to have had introduced into our stable that dread disease, epizootic abortion, and have lost a considerable number of calves and two cows in connection with it. Additional losses are the interference with records of dams in coming to milk at abnormal times, together with loss of time required to deal with this disease. Since April, 1894, the cows on the Experiment Farm have been treated daily, and at least one cow which has been invaded by the dreaded abortion germs has brought living issue in twin calves, which can doubtless be raised. This attack of disease may not be altogether a misfortune, since the calves lost have almost invariably been males, and, moreover, we may be able by next year to recall to the attention of farmers, who are struggling against the ravages of abortion, that the treatment recommended by Dr. Nocard has conquered the outbreak here.

A bulletin will soon be issued giving results of some dairy work and tests of dairy apparatus in the past two years.

In field crops our attention to crimson clover has been continued. The seeds distributed last year were followed by an information bulletin, which brings reports of failures and successes. When climate and soil are favorable this clover almost invariably succeeds. Its cultivation is extending, but not so fast as it will when the seed become cheaper. This will result when parties here begin to grow it *for seed* on a scale large enough to use a huller to clean the seed for market. As sold, with freight and commissions charged, the seed costs so much that many are deterred from commencing to grow it on a farming scale; yet this fact ought to push its growth *for seed to sell.*

During the spring the soy beans from last year's crop were distributed to 329 persons who applied for them and enclosed ten cents to pay mailing expenses on one pound packages. An information bulletin is just being returned by the recipients, with the report of the season's experience with this bean. So far (twenty-four reports received) a large majority have failed. The failures have been mostly in the plants not vegetating, or rabbits have eaten them. We have had failures from the latter cause, and possibly other failures are due to this cause. Many of these reporters planted the soy beans in corn. It has not grown so well for us in corn as when planted alone. Individual plants are not well developed, as

a rule. This crop needs the sun, and does not bear shading well. Two reports are of good crops of seed, and two of large yields of forage.

Besides soy beans grown with corn, the cow pea has been planted in hills alternating with corn, and both harvested for forage. A good yield has been obtained, which promises to more nearly approach a "balanced" ration than any other crop we have tried to grow together. This combination of common corn with the Unknown or Wonderful pea should be harvested before the peavines have interlocked their branches across the rows. The long vines are stubborn to pull apart after they have run together.

A comparative test of varieties of the cow pea was planted on the old wheat plats. The portion on which peavines were alternated with wheat for five years seemed to have become "peasick." The peas did not grow so well, lost their leaves sooner, and died down earlier than did the same varieties on the part where no peavines had been grown with wheat.

Some Wonderful pea-vines were grown for silage and hay with intention of making digestion experiments on both. Yields at harvest were 15.67 tons of fresh vines for silage and 5.8 tons of hay, after being stacked over a drying frame eleven days in the field.

An effort has been made to increase the forage plant, Lathyrus sylvestris, for the purpose of getting sufficient hay or fresh fodder for sheep digestion. We have a fair stand on about one-twentieth acre after considerable nursing.

Live Stock on Experiment Farm.—One driving horse and pair mules; one full Jersey cow, unregistered; one full Jersey cow calf (seven months); seven native and grade Jersey milch cows; two grade Jersey heifers; one cross-bred Guernsey cow, two years old; one full Jersey cow, being fed for her milk; one full Holstein-Friesian cow, being fed for her milk; one full Jersey cow, boarding; one native beef cow; one pair twin grade short-horn calves for baby beef; one horned Dorset ram (Tranquility, 140, D. H. S. B. A. A.); one horned Dorset ewe (H. B. and C., 127, D. H. S. B. A. A.); one horned Dorset ewe lamb; one Merino ram lamb; two Merino ewe lambs.

Additions to equipment in 1894 have been one farm wagon, silo repairs, one constant recording thermometer, one set caponizing instruments, one coal stove for office workroom, one wire rope and wheel support.

Among other experiments outlined for the future, is to renew the effort to breed grade short-horn cows from sire of

milking strain. This experiment is for the benefit of the native stock, and is needed. Next to breed grade, Dorsethorn, Hampshire, Merino, Southdown, and, possibly, Shropshire sheep from native ewes. While breeding these for the comparative value of these breeds crossed on the native sheep, opportunity will be furnished for minor feeding experiments, and sheep will be on hand for such digestion work as may be planned.

Summary of Record of Milk and Butter Production by Station Herd.

In presenting this summary it is due to state that of the cows reported in the last annual report, two died from effects of abortion, and one other was rendered worthless for comparisons by abortion. Besides these cows there have been milked at the Experiment Farm during the year three others, for periods ranging from three to four months.

Abortion in the herd this year has greatly interfered with a regular flow of milk. Cows which have been affected by this disease in 1894 are No. 2, Spot, Daisy E., Trixy's Rioter, and the three Guernsey-Jerseys, No. 14, and Miss Haley.

Daisy E. is a private family cow, the milk from which, in excess of family needs, has been turned into the dairy.

Polly B. is a full Jersey heifer that is being milked two years for her keep.

Cows numbered 18 and 19 were purchased to replace the two that died. Their record began in March; that of No. 18 on the 6th, and of No. 19 on the 21st.

F. E. Emery, *Agriculturist.*

	No. 2.	No. 5.	No. 7.	Spot.	Dora McKee	Trixy's Rioter.	No. 18.	No. 19.	Polly B.	Daisy E.	Fannie.
Least weight for year { month ..	Aug.	Feb.	Aug.	Mar.	Aug.	April	Mar.	Mar.	Feb.	May	Nov.
{ wt. in lbs	821.	837.	967.	761.	747.	565.	724.	739.	471.	931.	641.
Greatest weight..... { month ..	Dec.		May	July	April	Dec.	Dec.	Dec.	Dec.	June	Dec.
{ wt. in lbs	973.	984.	1095.	908.	930.	734.	848.	841.	592.	1043.	651.
Average weight for year, in lbs..	884.	908.	1022.	844.	841.	639.	789.	789.	525.	966.	645.
Yield of milk in 1894, in lbs.....	3872.1	4506.3	3918.	6175.2	3315.5	2565.7	3949.5	3897.8	3338.2	548.65	1165.95
Average per cent. of fat in milk..	5.015	4.07	4.44	4.71	6.42	5.304	5.60	5.97	5.65	3.90	5.188
Total butter fat from monthly tests, in lbs.....	197.24	205.95	180.74	297.45	212.76	143.907	230.63	228.014	181.76	218.46	61.82
Calculated yield of butter at 85 per cent. fat, in lbs.....	232.04	242.29	212.64	350.53	250.30	169.36	271.32	268.25	213.83	257.23	72.73
Calculated yield at 80 per cent. fat, in lbs	246.55	257.44	225.92	371.81	265.70	179.88	288.29	285.02	227.2	273.07	77.27

REPORT OF THE FIRST ASSISTANT CHEMIST.

DR. H. B. BATTLE, *Director:*

DEAR SIR: I present herewith a report of operations in the chemical division of the Station for the year 1894, together with a statement of work now in progress and outlined for the future. There have been made analyses of—

Commercial fertilizers	309
Marls	7
Manure	1
Mucks	4
Castor pomace	1
Nitrogen, reporter's sample	1
Phosphoric acid, reporter's samples	3
Soil samples of reporter	2
Soil	1
Coal	2
Pyrites	1
Ore	1
Vinegar	1
Boiler waters	4
Water residue	1
Mineral waters	51
Health waters	76
Coffee for adulteration	1
Carried forward	467
Brought forward	467
Human milk	1
Butter	2
Milk and cream	19
Fodder analyses in connection with digestion work	22
Fodder analyses	6
Tobacco	20
Corn and cow-peas for silage	6
Sweet potato vines	2
Cowpea-vines	6
Nitrogen and moisture determinations in mixed fertilizers in nitrate experiment	60
Fertilizer analyses of fodders	11
Urine	34
Minerals, ores, and rocks identified and values reported	86
Total	742

Fertilizer Work.—Besides the fertilizer analyses mentioned, quite a number of check analyses are made to insure the accuracy of the work, and not an inconsiderable number are made in the study of methods.

Work for the Association of Official Agricultural Chemists.—The samples sent out by the reporters of the Association of Official Agricultural Chemists on nitrogen, soils, and phosphoric acid have been worked. These samples required a great deal more time and work than ordinary samples, inasmuch as our methods of analyses are largely based upon the results obtained upon them. The writer was the reporter of the above association on phosphoric acid this year, and a not inconsiderable amount of time was taken in the collection of material and preparation of a report on that subject

for the association. In this connection I might state that, previous to beginning fertilizer work in the spring, and at other times when work on hand permitted, considerable work has been done in the study of new methods and points in connection with old ones for the benefit of our own laboratory.

Digestion Work.—The study of the digestibility and feeding value of North Carolina foods and feeding stuffs has been continued during the year by this and the agricultural division working conjointly. The investigations have been confined to rations of cotton-seed hulls and meal, and data for eight (8) experiments have been collected and will require but little more work to be presented as our fourth bulletin on digestion experiments. The work has been more complete this year than heretofore, in that the urine was collected and analyzed. The foods and fæces have also been studied from a fertilizing point of view.

The Decomposition of Nitrates in Mixed Fertilizers.—Mr. Carpenter has devoted considerable time during the summer to an investigation on the loss of nitrogen in various fertilizer mixtures containing nitrates. The results will appear in another publication.

Tobacco Work.—The Station commenced work on tobacco four years ago. The work of this year is in a somewhat different line from that of previous years. Twenty samples of tobacco grown in various localities in the United States, from which samples were not obtained in previous years, were collected at Chicago and have been submitted to analysis. Determinations were made of nicotine, ammonia, nitric acid, total nitrogen, ether extract, cellulose, ash, potash, lime, chlorin, sand, carbon, and water. This work is, in a measure, complete.

Dairy Products.—The laboratory has co-operated with the farm department in the analysis of milk, cream and butter, from time to time, to test the rapid methods used by the latter, and for other purposes.

Bulletin and Experiments on Sorghum.—Mr. Williams has devoted some time to the study of literature relating to sorghum, and to corresponding with farmers and others experienced in its growth and the manufacture of molasses from it. He made some experiments with lime-water as a clarifier at the farm of Mr. George Shellem and in the laboratory. The results of his study will be presented when time permits.

Bulletins.—Since my last report Mr. Carpenter has prepared and presented a bulletin on "The Marls and Phos-

phates of the State," and a joint bulletin on "Rational Stock Feeding" has been prepared by Mr. Emery and myself.

Hog Cholera Specific and Preservative for Dairy Products.—I comment upon only two of the numerous miscellaneous samples which have come to the laboratory for identification or analysis. One is "The Silver Live Stock Powder," which is recommended for most of the ills to which animals are heir. It consists mainly of ground bone with a small amount of charcoal and some carbolic acid. Carbolic acid is a strong germicide, and the mixture, no doubt, possesses some merit as a preventive of hog cholera and other like diseases, but one dollar per pound is entirely too much for materials that any farmer can buy for ten or fifteen cents and use just as effectively. The other is "M Preservaline," and is to be used to prevent milk and cream from souring, and butter from becoming rancid. This is boracic acid, and while sold at very reasonable price, should never be used to keep foods intended for *human consumption* at least. Any material that will prevent the growth and development of organisms in foods outside of the body will at least interfere with the activity of these or similar ones so necessary in the process of digestion.

Equipment.—The laboratory is in very good equipment for the work before us. The gasoline gas plant, put in in March, is furnishing a plentiful supply of gas of good quality for our work and at a much reduced cost from that paid for city gas.

The work of the division is shared equally by the different analysts, each man devoting his time, as far as practicable, to separate divisions of the work.

Respectfully submitted,

B. W. Kilgore,
First Assistant Chemist.

REPORT OF THE BOTANIST AND ENTOMOLOGIST.

DR. H. B. BATTLE, *Director:*

Concerning the work carried on in the botanical and entomological division of the Experiment Station during the present calendar year, I beg leave to submit the following report:

I. *Publications.*—During the year, as the result of former investigations, the following bulletins have been published:

1. No. 98—Leguminous Crops and their Value. 36 pages.
2. No. 100—Our Common Insects. 36 pages.
3. No. 105—The Chestnut and Its Weevil. 12 pages.
4. No. 108—Seed Testing, its Value and Uses. 76 pages.
5. Divers short articles contributed to the Station press service.

II. *Correspondence.*—The number of specimens of insects, plants and seeds sent to this division during the year has been large, and numerous letters have been written in answer to questions referred to the division.

III. *Field Experiments and Studies.*—Bi-monthly notes have been made upon the growth of the different species of grasses and forage plants grown on the forage plant garden at the Experiment Farm. A large number of half-pound packages of seeds of promising forage plants were donated to the Station by the Commissioners of Russia and Japan at the late World's Fair, being a portion of the exhibit of those countries at the Columbian Exposition. In addition to the above, a number of samples of forage plants indigenous to different parts of the world were procured through Vilmorin, Andrieux & Cie, of Paris, France. All these were sown in the spring of 1894. Such of them as failed to germinate well or to stand our summer heat were resown in the fall for seed saved for that purpose. The more promising of these plants will be more largely grown next year, and a report upon their value will be prepared for publication during the succeeding winter.

The final report on the so-called "permanent grasses" sown in the spring of 1891 is now nearly ready for the press.

This will make a companion bulletin to the one on leguminous forage plants.

The subject of seed testing and the improvement of the quality of seeds sold in our markets, which has been under study at this Station for a long time, has been brought to completion in its present form, and a bulletin giving the results of our studies is now in press.

IV. *Work on Hand or to be Undertaken.*—The work on hand includes the preparation of a bulletin on the indigenous medicinal plants of the State, one on the pests of cereal crops, and one on noxious weeds. The utilization of the spontaneous growth of our idle and waste lands now gives employment to thousands of men, women and children, and the products amount in value to at least a million dollars annually. North Carolina now exports largely to foreign countries and supplies the United States with the greater portion of the crude medicinal plants indigenous to our climate. These plants, whose usefulness in medical practice is so important, are nowhere cultivated, but gathered where they chance to grow wild. As the gatherers look only to present profit, no attempt is made to save the young growth or to permit mature plants to produce seed. Such is the constant and increasing demand for the more valuable of these plants that it is only a question of a few years when they will be practically exterminated unless in the meantime they are domesticated and cultivated as other crops of less value now are. To begin this work, a plot of ground should be laid off into beds, and the seed and roots of all the more important of our native medicinal plants planted thereon. The usefulness of such a herb garden need not be restricted wholly to domesticating our native wild plants. Medicinal and economic plants of other countries having a climate similar to ours can also be introduced. Closely related to the growing of medicinal herbs is the cultivation of essential oil and perfume-bearing plants. Our soils and climate are admirably adapted for the growth of such plants, but as yet little or nothing is known among our farmers of the value of such plants and how to utilize them. Recently there has come into prominence in the tanning industry a tannin-bearing plant indigenous to the dry plains of Arizona and New Mexico, and known there as "Canaigre." This plant is a species of dock (*Rumex hymenosepalus*), and is closely related to the curled dock and sheep sorrel so common in our meadows. There is little doubt of our ability to grow

this plant, and, as the demand is very great, a new staple crop may be added to our agricultural resources.

The only additional apparatus needed in this division is a Vienna seed germinating apparatus. The more important books on economic botany and entomology should be added to the division reference library as they are published. A rearrangement of the herbarium and insect cases are necessary to furnish room for material on hand for increasing these collections.

Very respectfully,

GERALD MCCARTHY,
Botanist and Entomologist.

REPORT OF THE HORTICULTURIST.

DR. H. B. BATTLE, *Director:*

I herewith present a statement of the work of the horticultural division of the Station for the past season.

In the matter of varietal tests of garden vegetables and small fruits, lack of space has of itself prevented our doing as much as is done in some of the stations, and a conviction of the small value of such tests has made me less anxious to attempt them. Of late it has become evident that this class of work has come to be considered a good means for advertising their products by seedsmen and nurserymen, and we are constantly receiving plants and seeds, without any previous arrangement or information, accompanied with a request to try, "and report." These things often arrive at a date out of season here for the article to be planted with any prospect of success, and after our plans and planting for the season are over. Then, months after, comes a letter asking for a report "to put in our new catalogue." Where any plant new to cultivation is offered, it may be of importance to test it, but with mere seedsmen's varieties of the common garden vegetables I cannot see that it is properly a part of our work to aid them in advertising it. Therefore, in the vegetable and small fruit line, I have considered it of far more value to study *species* and their best treatment to insure success in their cultivation than to study special *varieties.*

We have endeavored this season to study means for the prevention of the disease in tomatoes known as Southern Blight, which so sadly interferes here in the production of full crops of this vegetable. The true nature of this disease is a matter upon which there is a difference of opinion among scientific men, some believing it to be bacterial in its origin, while others attribute it to the attacks of a fungus of a higher stage of development, with mycelial growth and fruitage of spores. If this last is its character then it would seem feasible to combat it by means of the Bordeaux Mixture or some of the other commonly used fungicides. We tried the Bordeaux Mixture on a part of a plat of tomatoes, and waited

for the appearance of the disease, but all, both those treated and those left untreated, were clear of it. So we are still ignorant of the effect of the treatment. The tomatoes were all planted on land where we have never before grown any vegetables, and their freedom was doubtless due to being in uninfected soil. This disease affects all the Solanum family, potatoes and egg plants suffering as badly as tomatoes at times. So far, then, it would seem that a good degree of exemption from its attacks may be had by seeking fresh soil, where no plants of the Solanum family have been grown for some years. We expect to continue the test of fungicides another season.

Our hybrid sugar-corn is annually getting more fixed in character. We sent out small packets of it this year for trial in other parts of the State, but have had no reports from any one in regard to its success.

The new hybrid grapes from Mr. Munson, of Texas, have made a remarkable growth, but, owing largely to the frost of last March, made little fruit; so we can give no opinion as to their probable value here. The growth of some of them has been remarkable.

Sweet potatoes from seeds sent to us from Florida made small tubers, and we will keep them for propagation next season, hoping to secure in this way some improved varieties.

Hop roots planted last spring made but a moderate growth, and no results of value were gotten from them. It is hoped that they may do better the coming season.

After two seasons trial of a board coping over a grape trellis to prevent black rot, we find that the remedy is as bad as the disease. The coping prevents rot fully as well as spraying, but it furnishes such a harbor for the thrip insects that the foliage is destroyed by them, and ill-ripened fruit and a poor growth is the result. The coping will now be removed, and all the vines sprayed.

Grapes under glass were badly damaged by the March frost. The vines had been allowed to start early, for the purpose of testing their salable value in the northern markets before the advent of the crop from California. Having no means of heating the house, the frost caught them about blossoming time, and destroyed all the first growth, so that a crop of inferior grapes was the result. We are still of the opinion that the grapes of this class can be made a matter of profit to growers under glass, but some means must be at hand to keep up the temperature of the

house in the sharp frosts we sometimes have after they begin to grow.

We expect to take up next season the growing of seedling blackberries and raspberries from cross-bred seeds. The increasing interest in these fruits makes it desirable for us to secure the best sorts for our growers.

The investigation of the question as to the practicability of producing in our State the flowering bulbs now imported in such immense quantities for florists' use, is progressing favorably, and the indications are that a much larger part of the State will be found adapted to this culture than we at first supposed. A bulletin prepared on this subject has aroused general attention to the matter, and I have had letters on the subject from all the States from the Atlantic to the Pacific. Some of our growers in the eastern part of the State, who have been heretofore growing tuberoses, have gotten, and filled satisfactorily, contracts for other bulbs, and the indications are that the culture will rapidly extend.

All of which is respectfully submitted,

W. F. MASSEY, *Horticulturist.*

REPORT OF THE METEOROLOGIST.

DR. H. B. BATTLE, *Director:*

During the past year the State Weather Service has continued its operations as the meteorological division of the Agricultural Experiment Station.

Meteorological reports have been received from seventy-three stations, comprising fifty-two voluntary stations of the State Weather Service, and twenty-one belonging to the United States Weather Bureau. The following changes occurred during the year:

Established—

1. Stem, Granville County; observer, Dr. T. L. Booth.
2. Lilesville, Anson County; observer, J. G. Henry.
3. Pantego, Beaufort County; observer, Walter Clark.
4. Waynesville, Haywood County; observer, H. Taylor Rogers.
5. Fair Bluff, Columbus County; observer, I. M. Powell.
6. Moncure, Moore County; observer, Mrs. D. H. Moore.
7. Erie Mills, Montgomery County; observer, Jno. Scarboro.

The following stations were discontinued: (1) Rutherford College, (2) Jacksonville, (3) Lewiston, (4) Lillington, (5) Lilesville, and (6) May.

Reports will soon be received from Linville and Wilkesboro, and arrangements are being made to establish a station at Hot Springs, Madison County, in charge of the Southern Improvement Company, Dr. John D. Keilley, President.

There have been several changes in the *personnel* at stations now in operation, and one death.

New stations ought to be established in the central and eastern part of the State, and the purchase of one-half dozen maximum and minimum thermometers and the same number of rain gauges is recommended.

The reports received from voluntary observers have been, on the whole, fairly satisfactory, except in some cases where the exposure of the instruments has been faulty. The

monthly reports have been tabulated, as usual, and printed in the meteorological bulletins, of which twelve numbers have been issued during the year. Each monthly bulletin contains general remarks on the weather for the State during the month, notes by voluntary observers, accounts of local storms, meteorological data, including barometric pressure, temperature, precipitation, humidity, wind, weather, and miscellaneous phenomena, as dates of halos, fog, hail, frost, snow, etc.; tables of daily maximum and minimum temperatures, mean for all stations, daily precipitation, general summary of reports. These bulletins now contain valuable plates showing graphically the normal distribution of temperature and precipitation over the State. Eighteen hundred of the monthly bulletins are required, of which thirteen hundred copies are reserved for binding with the next annual report for the year 1894. Those who receive the eighth annual report will thus have complete meteorological data for the year. The seventh annual report, issued June, 1894, a pamphlet of sixty-three pages, gives an account of the work done and meteorlogical summary for the year 1893.

The publication of the weekly weather crop bulletin was continued from April 9 to October 2, 1894. Twenty-six numbers were issued, each edition being 1,600 copies. The number of crop correspondents was increased at the beginning of the year to 350, representing all of the ninety-six counties of the State. Of this number 150 reported regularly to the end of the season. The bulletin is highly appreciated all over the State and outside of it, and the number of copies issued (1,600) does not measure the wide extent of its distribution. The bulletin instantly reflects every fluctuation in the condition and probable yield of crops, and, on that account, surpasses in value other statistical crop reports generally issued at the end of the month. The last bulletin issued usually contains a review of the weather crop conditions during the preceding season.

It is recommended that next year, when reports of damage by insect pests are received, instruction be printed with the bulletin for that week how the pests may be exterminated. The co-operation of the Entomologist of the Experiment Station is solicited for that purpose.

The weather signals in use during the year 1894 were the usual flags, which are now familiar to almost everyone.

The number of stations receiving weather forecasts by telegraph at government expense from the central office at Raleigh is fifty-five; there are, besides, eleven receiving frost

warnings only, two receive cold-wave warnings only, and fifty-four additional places receive special storm or emergency warnings. Authority has recently been given to increase the number of stations receiving forecasts by telegraph, and it is hoped to increase the number to one hundred during 1895. Forecasts are sent by mail on postal cards or maps to a large number of places. The central office is very favorably located for that purpose, and supplies all postoffices within a circle of one hundred miles radius. The number of stations receiving forecasts by mail from Raleigh is 267. Another system of distributing forecasts by displaymen has also been adopted. Any displayman who receives forecasts by telegraph, and who is willing to undertake the work, is provided with a logotype outfit, ink-pad and a supply of addressed postal cards on which to duplicate the forecasts. The number of logotypes furnished is sixty-eight, which enables almost any forecasts to be rapidly set up and printed. Each postmaster receiving the forecasts is supplied with a bulletin-board on which to post the cards each day as received. Logotype outfits are furnished to displaymen who will mail forecasts to five or more places.

The gentlemen who have adopted this system certainly deserve much credit for their zeal for the service and their willingness to undertake a work yielding no pecuniary return. Five displaymen of the State Weather Service are already engaged in this work, and more are desired:

They are Mr. Will. X. Coley, Mocksville, N. C., who duplicates forecasts to 29 places; Mr. L. B. Abernethy, Rutherford College, N. C., who sends forecasts to 6 postoffices; Mr. J. H. Collins, Nashville, N. C., to 5; J. W. Thomas & Co., Thomasville, N. C. (Mr. Joshua Beck, displayman), to 5; and Mr. S. H. Smith, Winston, N. C., to 6.

The entire number of places in North Carolina thus supplied with the weather forecasts by telegraph or mail is nearly 500, a very large increase over former years. The regular increase of the number of stations receiving forecasts proves their value; but in order to obtain definite information, a report will be called for from every person receiving the forecasts of the number of lives or amount of property saved by the warnings.

During the year two voluntary stations of the service were inspected and the exposure of instruments corrected. At one all the rules for the proper exposure of instruments were being violated, and the case shows the urgent necessity for a regular inspection of all voluntary stations.

The central office at Raleigh was this year established as the center for the distribution of flood warnings. This service will, undoubtedly, be of much value to farmers living on the lower courses of the rivers in the eastern part of the State, especially in the lower Roanoke. Arrangements have been made for telegraphing the warnings to the Superintendents of the State farms, where interests exceeding $50,000 annually may be benefited.

A comparison of this report with those of previous years will show a steady increase in the work of the North Carolina State Weather Service, and a higher appreciation of its usefulness to the people than ever before. All the objects of the Service are accomplished in a very satisfactory manner by the distribution of forecasts, by the various publications, meteorological bulletins and crop reports, and by the considerable amount of special correspondence with persons outside of the State relative to its climatic features.

C. F. VON HERRMANN,
Meteorologist.

North Carolina Agricultural Experiment Station,

IN ACCOUNT WITH

The United States Appropriation.

1894.			*Dr.*
	To receipts from the Treasurer of the United States as per appropriations for the year ending June 30, 1894, under Act of Congress approved March 2, 1887		$15,000.00
		Cr.	
June 30.	By salaries	$7,038 91	
"	wages	360 00	
"	apparatus and reagents	640 74	
"	stamps, stationery, and miscellaneous printing	738 73	
"	express, freights and incidentals	830 83	
"	periodicals and books	156 60	
"	bulletins and paper	1,642 70	
"	farm labor	1,217 16	
"	farm supplies	1,038 95	
"	implements, instruments and equipment	295 25	
"	fuel and stoves	148 35	
"	gas	224 20	
"	telephones	190 00	
"	co-operative experiments and travelling	187 00	
"	annual reports	290 58	
	Total		$15,000.00

The undersigned, duly appointed Auditor for the State Board of Control, hereby certifies that the above items of expenditures made by the North Carolina Agricultural Experiment Station for the fiscal year ending June 30, 1894, are made up from the books of the Auditor of the Board and the Treasurer of the State of North Carolina (Treasurer *ex officio* of the North Carolina Agricultural Experiment Station), and that the receipts from the Treasurer of the United States for the year named were $15,000, and the disbursements $15,000, for all which proper vouchers are on file in the office of the Treasurer above named.

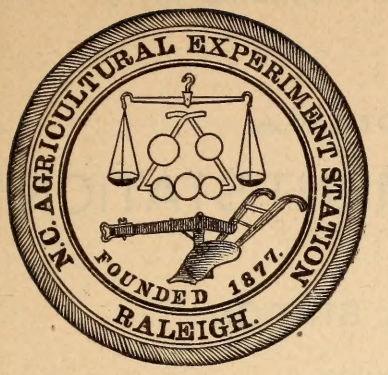
(Signed) T. K. Bruner, *Auditor.*

I hereby certify that the foregoing statements, made up from vouchers on file in this office, to which this is attached, is true and in accordance with the records of this office.

(Signed) S. McD. Tate, *Treasurer ex-officio of the N. C. Agricultural Experiment Station.*

The above are the signatures of the Auditor and Treasurer of the North Carolina Agricultural Experiment Station.

(Signed) H. B. Battle, *Director N. C. Agricultural Experiment Station.*



January 1, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 94.

HORTICULTURAL TESTS AND RESULTS

WITH

GARDEN VEGETABLES, FRUITS, AND BULB CULTURE.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

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RALEIGH, N. C.

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HORTICULTURAL TESTS AND RESULTS

WITH

GARDEN VEGETABLES, FRUITS, AND BULB CULTURE.

By W. F. MASSEY, Horticulturist.

I. GARDEN VEGETABLES.

It has not been found practicable to conduct very extensive varietal tests, and only certain kinds are taken up annually. The attention of the horticultural division is mainly devoted to a study of methods for overcoming climatic difficulties with certain vegetables, new modes of culture and new crops for the South, together with systematic efforts to improve our small fruits by producing new varieties from seeds.

Cabbages.

Two varieties of early cabbage were tested the past season. One was an improved strain of the Early Wakefield, known as the *Charleston*. This variety is nearly, if not quite, as early as the old Wakefield, and makes a much larger head. The other was a variety known as *Burpee's Surehead*. Little if any difference could be seen in season between the two, and both headed certainly and regularly. The production of good heads of cabbage in late summer and early autumn is a difficult matter in this climate, but we have demonstrated this season that in a season of uniform moisture like the past, it can be done successfully, if the caterpillars are kept down. This can best be done by regular hand picking. We have also found that a mixture of air-slaked lime and salt, two parts of lime and one of salt, is very effectual in destroying the larvæ and seems to help the cabbages. Pyrethrum powder is good if fresh, but a pure and fresh article is expensive. For a late winter crop, seed sown late in July and transplanted a month later will give better results than earlier sowing, and fine heads can be had by Christmas or earlier.

The requisites for a good crop of fall and winter cabbage in this latitude seem to be: 1st. Heavy fertilization of the soil either with stable manure or a high grade ammoniated superphosphate. 2d. Incessant watchfulness to keep them free from insects. 3d. Constant and regular cultivation from the start. 4th. The use of a good strain of American grown seed. Most farmers appreciate good blood in an animal, but few understand that a good pedigree is of as much value

to a plant as an animal. Cabbage seeds grown in the moist climate of England can be put on our market at a lower price than American grown seeds can be produced—and there are jobbers in seeds that put these on the market as low priced seeds. They are the most costly seeds our growers can use, not because they will not grow, for they will, but because cabbage seed developed in the English climate will not head so uniformly as American grown seeds. Our growers had better pay $10 per pound for American seeds of good pedigree than have the imported seed given to them, though the imported seed will test fully as well in a laboratory test as the American grown Our leading seedsmen now offer under various names stocks of cabbage seed bred to great perfection in our climate. We have found the following perfectly reliable and of uniform quality.

EARLY CABBAGES.

Early Wakefield from various growers.—This is the standard early cabbage used by our market growers. All the stocks of this cabbage have been much improved of late years. Twenty years ago four or five types of head, and degrees of earliness, could be found in almost any lot of Wakefield cabbage. Now the stocks of our leading seedsmen have all been so carefully selected that the Wakefield is a uniform type of blunt conical heads, heading uniformly and together. Several separate types have been selected out of it. Among them one of the best is the

Charleston or Large Wakefield.—We had this also from more than one dealer, and for this latitude we are of the opinion that it should supersede the old type because of larger size, and little if any later.

Burpee's Express—This is an extra early cabbage of the Wakefield type, smaller in head, and earlier than the Charleston. Its outer leaves have a more upright habit, and more plants can be grown on an acre than of the Charleston, but with us it is much smaller.

Early Winningstadt.—But for its wide spreading outer leaves and the greater room needed, we could consider the Winningstadt one of the best early cabbages for this latitude. At the North it is always rated a second early, but we have repeatedly shown that southward it is little behind the Wakefield, and is one of the hardest and most certain headers. But it must be planted much further apart than other early cabbages—which is an objection. Winningstadt is less liable to run to seed from getting too large an autumn growth than others.

SECOND EARLY CABBAGES.

Henderson's Succession and *Fottler's Improved Brunswick* are so much alike that we confess we cannot well separate them. They are both very uniform headers, of large flat heads, with exceedingly stout stems, and are as good as we know of as a succession crop up to July, and as a late crop to grow from seeds sown late in July or early in August.

LATE CABBAGES.

We have made no varietal tests of late cabbages, except Premium Flat Dutch and the above varieties. The strains of Premium Late Flat Dutch Cabbage now offered by our leading seedsmen, are all remarkably pure. But heretofore the climatic difficulties have deterred us from attempting a comparison of varieties offered under other names. This we hope to do the coming season.

MELONS.

We made last year quite an extensive varietal test of muskmelons, with a view to determine the sorts best adapted to our climate. The test was continued the past summer with the hope of verifying the conclusions formed. But, owing to wet weather at ripening time, no results of value were obtained, except as to the resistant qualities of some.

Burpee's Netted Gem.—This is probably the earliest and most prolific of the nutmeg cantaloupes. Flesh green, thick and sweet. A very valuable sort for early market.

New Early Hackensack.—Flattened, deeply ribbed and well netted. Flesh green. Earlier than the old Hackensack. Fair size and a good shipper.

Montreal Market.—This a green-fleshed, deeply ribbed, late melon, which grows to an immense size. It makes a fine melon to look at, but it is late, and of such inferior quality that no one accustomed to good melons would care to eat it. Will do to grow for the fall fairs for people to stare at. Specimens have been grown weighing nearly 40 pounds, and 18 to 20-pound melons are about the average.

Emerald Gem.—In all of our tests for years this variety has uniformly stood first as to quality of fruit. Skin slightly ribbed, dark grass green, with silvery stripes in the depressions. Flesh very thick, and of a deep orange color. We are satisfied that as to flavor it is unexcelled. It is not so early as some others, but is prolific, and should make a good market melon in a market where its quality becomes known. It stands wet weather better than most others.

Acme, Baltimore Market, or *Anne Arundel.*—A melon largely grown in Anne Arundel County, Maryland, for the Baltimore market. It is one of the earliest and most prolific of the green-fleshed nutmeg melons. Slightly oblong in shape and pointed towards the blossom end. Skin finely netted. One of the best market sorts, and of uniformly fine flavor. Rather the best of the green-fleshed sorts.

Osage, Miller's Cream, Miller's Hybrid.—Osage is probably the proper name for this variety. Rind green, shading to a yellow flesh. Early, of good size and fair quality, and is being grown considerably for market. Not so productive as the Baltimore Market.

Bananas.—A curious looking melon, like an immense cucumber. Skin smooth and yellow; flesh orange color. We have grown this melon four feet long. Very large specimens are usually of good

flavor, but most of the smaller ones are very poor flavored. Only worth growing as a curiosity.

Surprise.—This, with us, did not agree with any of the catalogue descriptions. In general appearance it looked like the Banana melon pushed endwise into a roughly round shape. Skin yellow; flesh salmon color. Quality poorer than Banana. Worthless.

Banquet.—A perfectly globular melon, with a densely netted skin. It was sent out as of better quality and larger size than the Emerald Gem. With us it was decidedly smaller, and much inferior in quality. The flesh is deep orange salmon, and very thick. Too small for market and too poor for home use.

Delmonico.—An oval shaped melon, ribbed and netted on the outside. Flesh deep orange color, and quite thick. Quality good, but not equal to Emerald Gem. Will make a good market sort.

Garden Corn.

For some years past we have been endeavoring to fix a good variety of sugar corn adapted to a southern latitude. For this purpose, we have been using a cross between the Leaming, an early yellow field corn, and the Mammoth Sugar Corn. This cross was made by Mr. McCluer, of the Illinois Station, in 1888. Some of this of the second season's growth from the cross was placed in our hands in the fall of 1890, and first planted here in spring of 1891. This cross was selected because the Mammoth Sugar has always succeeded better in the South than the early sorts, and the Leaming gave earliness and stamina. The Leaming being a yellow corn would enable us to select seed combining the characters of both. We have grown this corn now for three seasons, always selecting for planting the yellow wrinkled grains. It is not yet fully fixed in its character, as a considerable amount of mixture still appears in the grains, but by persevering selection we hope soon to have a variety well suited to Southern gardens. It grows of fair medium height, and is quite early. Selected seeds will this season be placed in the hands of a few careful cultivators at other points in the State, with the hope that the selection will be continued. Will continue to select and plant it here.

Cucumbers.

The cucumber crop having attained considerable importance in our State as a market crop, we propose this season to make a comparative test of varieties. Cucumbers are largely grown under glass in winter around the Northern cities, and are sold at high prices. As all winter forcing must be done there at great expense in houses and with extra fuel, it is an interesting question to determine whether in our milder climate the same culture cannot be done fully as well and at a larger profit. A large grower of forced cucumbers near Boston has been seriously considering the advisability of moving his plant to North Carolina. As these forced cucumbers sell at prices ranging

from $1.25 each to 10 cents for last crop in spring, it can readily be seen that there is room for the appliance of extra expense and skill in their production. Experiments in this culture will be made at the Station the present winter. Our gardeners do not take as much advantage in the use of glass as they might, and we desire to show the desirability of acquiring skill in this department of culture. Every market gardener who wishes the best success should have at least one small greenhouse, heated by flue or by hot water, for the purpose of forwarding plants of many kinds, and an abundant supply of sashes on frames for protecting and forwarding plants for setting in open ground, or for growing some things at an earlier period, and thus get in advance of his natural climate. The use of oiled cotton cloth is a poor substitute for glass, and it is in the long run more expensive. Cotton cloth is useful only for protection in spring, but is of little value for winter work. It is our purpose soon to prepare a special Bulletin on the use of glass.

Egg Plants.

Experiments, which we have made, show that a gardener with a good supply of sashes, and a greenhouse for starting the plants in pots, can put this crop in market by the first of July, at which date they will always pay very well. They are hot-weather plants and cannot go out early. When sashes have been used for forwarding tomato plants, and after the tomato plants are moved to the open ground, egg plants that have been grown in pots in the greenhouse, can be set two plants to a sash, and the glass still kept over them until weather is warm and settled, and thus brought early into bearing. We once grew 600 sashes in this way in Northern Maryland and put the product in market ahead of those from Charleston. A similar practice here would be more effective.

Lettuce.

We have made no extensive varietal tests of lettuce since 1891, but have found no variety that excels the Boston Market for growing in frames for shipment. It is easy here with only the use of sashes on cold nights to have lettuce headed well for shipment by Christmas and during January, at which time it will always command a remunerative price, particularly in the Washington and Baltimore markets. It is a curious fact that the supply of winter lettuce to these cities comes largely from Boston, where it is largely grown in fire-heated greenhouses. As equally good lettuce can be grown here with the simple cover of a sash or a cold frame, it would be to the interest of our growers to look into this matter.

Onions

For two seasons past we have made special varietal tests of onions, and also modes of culture. Our land at the Experiment Farm is

poorly adapted to the culture of this crop, being a compact red clay, and yet our success with them shows plainly what can be done in this line here. We have demonstrated that for the production of ripe onions the old practice of using sets is not necessary, since fully as large crops of better onions can be made here by sowing the seed. Owing to the fact that our autumn weather is apt to be dry, and seed difficult to germinate, it is probable that for the production of early grown onions for bunching in February and March, it will always be better to use sets. But when seed can be got to germinate well in September the process is cheaper and just as good in product. For the main crop we have used two methods of sowing seed. One is to sow them thickly in cold frames protected by sashes in January and transplant them to the open ground late in February. The other is to sow the seed directly where they are to grow, as early in February as the soil can be well gotten in order. The transplanted onions will with some varieties make much larger bulbs, while with some others the difference is not enough to make the extra expense profitable. The Italian varieties are generally large and early, but they and the Spanish or Bermuda are bad keepers, and when the crop is grown for the local market the next winter they should not be used. They are useful for shipping North as early ripe onions. We give the results of our tests as follows. It is to be noted that a globular onion usually gives a better crop than a flat one, and is almost invariably a better keeper.

AMERICAN ONIONS.

Southport White Globe.—A New England variety. Round as a base ball, very solid and a good keeper, makes a fine crop from seed sown in February and not improved by transplanting. We consider this the best white onion for main crop.

Large Red Globe.—A fine cropper of large globular shape, and brings the highest price of any red onion. Worth further test.

Wethersfield Large Red.—A large, rather flat onion, but a good cropper and good keeper. Very strong.

New Opal.—The seed of this was received from Messrs Tait & Sons, Norfolk, Va, with special recommendation as to its keeping quality. We have found it all that is claimed for it. Shape roundish, flattened; color light red. This is the most solid and heavy for its size of any we grow, and is a remarkable keeper.

Extra Early Red.—A flat onion. Fair cropper and quite early.

Round Yellow Danvers—An early round yellow onion, but not equal to the

Yellow Globe Danvers.—This is one of the finest globular yellow onions we have tested. Does well transplanted, which few of the American sorts do.

ITALIAN AND SPANISH ONIONS.

New Mammoth Pompeii.—A large, flat, pinkish onion, which, when

transplanted, grows to a very large size. Also gives a fine crop from seed sown in February, With one exception, the Giant Rocca, we have found these Italian onions all poor keepers.

Giant Rocca.—A very large onion of a reddish brown color. It should always be sown early and transplanted, as it is a late variety, and requires a long season to attain full size. When thus treated it reaches enormous proportions.

Queen.—A flat white onion; among the earliest of all. Very similar, but rather smaller than the

Pearl.—A flat white sort, now getting popular as a variety to grow from fall planted sets for early bunching. For this purpose it is unsurpassed.

Large White Italian Tripoli and *Large Red Italian Tripoli* are both quick-growing, flat onions, of similar character but different color. They will do well for early shipment as ripe onions.

Giant White Garganus.—This is the earliest very large onion we have tried. Rather flat in shape. A good cropper, and ought to make a profitable onion for early shipment ripe.

Barletta.—A small white onion of quick growth. It makes pretty little onions of uniform size, and would be desirable for pickles. It can be sown in August, after some early crop, and make a good crop of pickles.

Bermuda Onions, Red and White.—These are really Spanish onions. They grow quickly, are very flat in shape, but are very poor keepers. They might be made a profitable onion for early shipment as ripe onions, but we think the Garganus better.

Prize Taker.—This is a Spanish variety, and is the big yellow onion so often seen at our grocery stores, It makes a much heavier crop by being sown early under glass and transplanted, and should always be treated in this way. It is not a good keeper but better in this respect than most others of the class.

POTATO ONIONS.

These make no seeds, but increase by the offsets. They are therefore always grown from sets. Being bad keepers, the sets should always be planted in the fall. There are two sorts, the yellow and the white. We have found the yellow the largest, and it is a profitable sort to grow for shipping North as an early ripe onion; but the crop must be disposed of as soon as ripe. The white potato onion promises to be valuable as an early grown bunching onion.

RESULT OF TEST DURING 1893.

The tabulated statement below gives the result of the test of several varieties. Onion seed were scarce in spring of 1893, and we used, without preserving name of seedsman, much old seed. The result shows that most of the seed sold was probably two years old. The stand was poor, and crop a failure. Our notes are largely from results of 1892, when crop of all was good.

TEST OF ONIONS DURING 1893.

	VARIETY.	SOURCE.	DATE SOWN IN OPEN GROUND.	GERMINATED.	HARVESTED.	RESULT.
1	Red Globe	Burpee	March 5	March 30	August 4	Medium size; early; good keeper.
2	Pale Red Bermuda	Two-year seed	" 5	" 29	" 4	Flat; poor keeper.
3	White Portugal	Two-year seed	" 5	" 23	" 4	White; mild; keeps well.
4	Giant Rocca	Tait	" 5	" 24	" 4	Large brown; poor keeper.
5	White Victoria	Burpee	" 5	" 25	" 4	Globe shape; good keeper.
6	Queen	Old seed	" 5	" 28	" 4	Early; white; good for bunching.
7	Yellow Danvers	Old seed	" 5	" 29	" 4	Round; yellow; good keeper.
8	Barletta	Old seed	" 5	" 29	" 4	Flat; white; early; inferior to Queen.
9	White Garganus	Tait	" 5	" 28	" 4	Large and good, but keeps badly.
10	Wethersfield Red	Old seed	" 5	" 30	" 4	Good cropper and fine keeper.
11	Extra Early Red	Burpee	" 5	" 24	" 4	Early; medium size; keeps well.
12	Prize Taker	Burpee	" 5	" 27	" 4	The most showy onion; heavy cropper.
13	Red Victoria	Old seed	" 5	" 28	" 4	Medium size; bad keeper.
14	New Opal	Tait	" 5	" 20	" 4	Flat; hard and fine keeper.
15	Round Yellow Danvers	Burpee	" 5	" 23	" 4	Next to Prize Taker.
16	Large Red Wethersfield	Tait	" 5	" 23	" 4	Old well known red; good keeper.
17	Mammoth Pompeii	Old seed	" 5	" 20	" 4	Large and fine but worst keeper.
18	White Globe	Burpee	" 5	" 20	" 4	Seems identical with No. 20.
19	White Bermuda	Old seed	" 5	" 23	" 4	White; flat; will not keep.
20	Southport White Globe	Tait	" 5	" 22	" 4	Globe shape; good keeper; finest white.
21	No name	Burpee	" 5	" 21	" 4	Sent for test without name; small, soft and very poor keeper.

Irish Potatoes.

No extensive varietal tests have been made recently, as our attention has been directed mainly to a series of experiments to determine the value of our late fall crop for seed. We began a series of experiments in connection with the New York Cornell Station and the Maine Station, they sending us potatoes raised there to plant in comparison with fall crop raised here the previous year from same stock; while we were to send them fall-grown Southern potatoes for planting there. The results here were strikingly in favor of the Southern-grown seed. For some reason the Northern stations dropped the work and sent us no seed this season, and we have had no report from those sent from here for planting there. It seems evident that a large demand is soon to spring up for the late crop potatoes for planting North, as many Northern gardeners have found these to be superior for planting there to their own seed.

The crop of early potatoes was small with us this year, but the favorable autumn made the late crop unusually fine.

It is proposed to experiment further by keeping over some of this season's late crop to plant next summer in comparison with the crop of same season.

Tomatoes.

The past season has been particularly unfavorable for tomatoes here, both early and late. The bacterial disease known as Southern Blight was particularly destructive, both on the Station and College farms. We have made but few varietal tests, being engaged mainly in studying how to prevent blight, or to produce varieties resistant to the disease. Among the new varieties tested, a sport from Essex, the *Lemon Blush*, a new variety raised by Mr. E. S. Carman, was the most perfect tomato we ever raised, and seemed resistant to disease. *Terra Cotta*, a seedling of Mr. Carman's, raised from a cross of Ignotum on Peach, was found to possess valuable qualities. It is of a dull terra cotta color, with lusterless skin like the Peach tomato, and while apparently soft, has wonderful keeping qualities; entirely destitute of hard core; for home use valuable in its present shape, and likely to prove of use in crossing; resistant to disease. The most productive tomatoes here, and most resistant to climatic influences, are the plum and pear-shaped varieties. We propose to take up the work of crossing them with Terra Cotta and others, hoping to develop a variety more valuable in this climate than any we now have. The tomato crop of 1893 was very inferior as a rule, and the results with the varieties tested can hardly be considered conclusive.

TEST OF TOMATOES DURING 1893.

VARIETY.	SOURCE.	SOWN.	GERMMINATED.	PLANTED.	RIPE.	RESULT.
Matchless	Burpee	Feb'y 10	Feb'y 24	April 3	June 29	Large, solid and good; second early.
Trucker's Favorite	Burpee	" 10	" 27	" 3	" 27	Good; smooth and solid.
Nichols' No. 5	Nichols	" 10	" 20	" 3	" 23	Good; medium size; early.
Lemon Blush	Thorburn & Carman,	" 10	" 20	" 3	" 22	Solid; very smooth, but yellow.
Lorillard	Thorburn	" 10	" 21	" 3	" 29	Round; smooth red; healthy.
Golden Ball	Livingston	" 10	" 22	" 3	" 28	Medium size; smooth; yellow.
Large Rose Peach	Livingston	" 10	" 20	" 3	" 24	Rather larger than Peach; no better.
Buckeye State	Livingston	" 10	" 22	" 3	" 25	Rotted badly; failure.
Aristocrat	Livingston	" 10	" 22	" 3	" 25	Rotted badly; failure.
Favorite	Station	" 10	" 23	" 3	" 23	Large; smooth; best.
Early Ruby	Station	" 10	" 21	" 3	" 19	Earliest of all; not smooth.
Ignotum	Station	" 10	" 21	" 3	" 23	Rotted and failed, as it always does.
Mikado	Station	" 10	" 21	" 3	" 23	Large; rough; early.
Livingston's Beauty	Station	" 10	" 22	" 3	" 23	One of the finest.
White Globe	Thorburn	" 10	" 21	" 3	" 29	Promising; crop failed.
Terra Cotta	Thorburn & Carman,	" 10	" 22	" 3	" 22	Early; productive; good for home use and crossing.

II. FRUITS.

Strawberries.

We have been testing for two years a large number of seedling strawberries of our own production. By far the larger number will be discarded. Eight varieties were selected and named for further test. As these names are only tentative, we will still hold them by numbers and not allow them to go out under name until we feel sure that they are worthy of the names.

No. 1. Has for two seasons proved to be an excellent berry; large, very productive, well flavored and firm; second early.

No. 2. Firm; good size and shape; promising.

No. 3. Very prolific; smooth large and excellent.

No. 4. Very late; extends the season, but is rather soft.

No. 5. One of our best, of fine shape and good cropper.

No. 6. A very fine large late berry, but we fear too soft.

No. 7. A good late berry, but inclined to be soft.

No. 8. Very large and fine, but we fear too soft.

We have tested other varieties with the following result:

West Lawn.—A new variety from Bauer Bros., of Judsonia, Ark. This was the earliest berry ripe with us the past season. A large conical, firm berry resembling Sharpless. The most promising early berry we have tested.

Belle.—From Cleveland Nursery Co., Rio Vista, Va. Long solid berry, prolific, early as Michal's and far superior to it. Makes many immense coxcomb fruits.

Thompson's No. 9.—From same source. Rather smaller but of more uniform shape than Belle, and later. A good bearer and good flavor. Promising.

Parker Earle.—This much praised sort cannot be recommended for market purposes. It sets an immense crop, but ripens it slowly and runs down small. Might be useful in a family garden, but perfectly worthless for the market grower.

Smettzer's No. 2.—A large but irregular berry, too soft for market and not very productive.

Raspberries—Blackcaps.

Jackson's May King.—Ripe June 1st. Blackcap. Small, dry, not worth growing.

Ada.—Ripe May 25th. A small blackcap, not productive nor good.

Lovett's Best.—One of the finest of its class; very productive of fine fruit. Ripe May 26th.

Thompson's Early.—A complete failure.

Cromwell.—Ripe May 23d. Earliest and a good bearer. Promising.

Smith's Prolific.—Ripe May 27th. Very productive and stands climate well.

Palmer.—Ripe May 25th. Very prolific, large and good. Promising.

Blackberries.

Child's Tree Blackberry.—The name is deceptive, for it is not tree-like in any way, but has the ordinary habit of high bush blackberries. The fruit is good size and of good quality. Ripens too scattering for a market berry. Ripe June 19th.

Early King.—The earliest; a heavy cropper of fine sized fruit. Promising.

Thompson's Early.—Very early. Large fruits, fine cropper and solid when black for shipment.

Lovett's Best.—A late berry of medium size, rank growth and moderate crop.

Child's Wineberry.—A Japanese species of the Raspberry family. The canes grow rankly, and the stems are covered with reddish hairs, as is also the calyx of the fruit. Fruit bright red, and of a sprightly acid flavor. Quite unproductive, and of no use except as a curiosity.

Grapes.

A large portion of the varieties of grapes that have been in cultivation here, over 120 varieties, have been discarded as of no special value. Our chief work the past season with grapes has been in experiments to check the black rot and other fungus diseases.

We have planted a number of cross-bred seedlings raised by Mr. Munson, of Dennison Texas, which have not yet fruited, but from which we anticipate some good results, as they are a departure from the kinds usually sent out at the North, being crossed with native Southern species and therefore more likely to suit our climate. The only new Northern grape fruited this year was the

Green Mountain sent by Messrs. Stephen Hoyt Sons, of Connecticut. This is a good healthy grower. Greenish white fruit and is the earliest *good* grape we have tried. It ripens as early as the worthless Champion. Skin quite tender and pulp sweet and pleasant. We fear it will not ship well. This is identical with the *Winchell* grape sent out by Elwanger and Barry, of Rochester, N. Y., and one of the names should be dropped.

Prevention of Grape Rot.

Having a long trellis, mainly covered with Concord vines, on the west boundary of the Station grounds, we closed the west side of part of the trellis with boards, and placed a coping of boards projecting 18 inches on the top on the east side. This part of the trellis had no other treatment. The remaining part was sprayed three times with Bordeaux mixture. Both parts were nearly free from rot, while

vines exposed and not sprayed lost their entire crop from rot. The sheltered trellis protected the vines from rot fully as well as the spraying. But later in the season the Thrip insect developed in great numbers under the shelter, and destroyed the foliage to such an extent that the grapes did not ripen well. The experiment will be continued next season with the coping alone. We are inclined to think that a cheap coping can be made that will ward off rot as effectually as spraying, and be fully as cheap.

GRAPES UNDER GLASS.

Our grapery for the culture of the exotic grapes was completed and planted June 10, 1891. The vines made such a remarkable growth during that summer that several of them were allowed to ripen a bunch or two of fruit in 1892. The past summer the house produced a full crop of remarkably fine fruit, bunches of nearly four pounds weight being cut; and the house, 16 x 30 feet, produced about 350 pounds of grapes. The house was built for two purposes: First, for cross breeding with our native grapes to raise improved varieties; second, to test the practicability of growing these grapes profitably under glass for shipment. No fire heat is used in the house, and the vines, after pruning in the fall, are laid down along the inner side of the wall, exposed to the cold through openings in the wall, and covered with boards and earth to keep them from being affected by the warmth of the glass in winter. The past season they were kept back in this way as late as possible in spring, so as to have fruit for exhibit at the State Fair. We made one small shipment of fruit to Boston, which, unfortunately, reached there at the time of the first arrival of California grapes, and sold for only 20 cents per pound. Two weeks earlier they would have sold for 75 cents, at which price there is a good profit in growing them. The coming season the vines will be allowed to start earlier, so as to have the fruit ready to ship last of July or early August, at which date they will doubtless bring good prices, as the California product is not in.

For hybridizing purposes, we have planted in the house one of Mr. Munson's seedling grapes, "*Brilliant*," and soon hope to produce some hybridized seedlings.

Figs.

Though we have over thirty varieties of figs under cultivation, we have, as yet, had no opportunity to give full comparison of quality of fruit, since our plants have been kept cut too hard for propagation to supply the demand for the trees. As we have now closed the distribution of plants, we hope to have an opportunity to ascertain something definite in regard to the hardiness of the plants, quality of the fruit, etc. The severe winter of 1892-'93 cut down all unprotected figs to such an extent that the crop was a failure this season.

The following sorts seem to be the hardiest in winter: Brown Turkey, or Brown Ischia, Osborn's Prolific, Black Provence, Early

Violet, Negro Largo, Violette de Bordeaux, Black Marseilles, Roi des Noirs, Black Ischia, Castle Kennedy, and Pitaleuse. These were all unhurt by winter of 1891-'92 The following were but slightly hurt at tips same winter: Angelique, Black Bourjassotte, White Bourjassotte, Grosse Vert, Brunswick, Bourjassotte Grise, Adriatic, White Marseilles, and San Pedro. The White Genoa was badly cut down. In the winter of 1892-'3 *all* of these were cut nearly to the ground by the unusual cold.

So far as tested, the following seem to be most productive: Brown Turkey, Celestial, Early Violet, Black Provence, Osborn's Prolific, Castle Kennedy, Negro Largo, Adriatic.

In quality, so far as fruited, we rank the following in order named: San Pedro, Adriatic, Angelique, Brunswick, White Genoa, White Marseilles, Celestial. The Celestial is the smallest of all figs, but can be eaten out of hand without skinning, as the skin has none of the acidity of the larger sorts.

Though figs of all sorts usually survive our winters without trouble, we have occasional winters in which they are badly hurt, like the last one. It is always safer then to protect at least with a shelter of pine boughs or by bending the branches to the earth and covering them with soil. This is much more quickly done than might be imagined. We have treated some of our trees in this way the present winter, and will look with interest for the results.

Peaches.

A satisfactory experiment was made the past season in the use of Bordeaux mixture to prevent the rot in peaches. A portion of our orchard was carefully sprayed and on this part a fine crop was matured. On the remainder no spraying was used, and hardly a sound peach was saved.

We would recommend spraying the trees at three different times. First, before the buds swell; second, as soon as the bloom falls; third, when the peaches are stoning or half grown. The first application should be full strength, the other two half strength.

III. BULB CULTURE.

The special adaptability of the soil and climate of North Carolina for the culture of flowering bulbs, now so largely imported from Europe, has of late attracted much attention among Northern florists.

Tuberoses, Lilies, Gladioli, and Hyacinths.

In a small section in the eastern part of the State, Tuberose bulbs have been grown with great success for some time, so that now the market for these bulbs, both in this country and in Europe, is largely supplied by North Carolina growers. It has been demonstrated that our soils and climate are equally well adapted to the growth of Lilies, Gladioli, Hyacinths and Narcissus. For the purpose of introducing the culture of some of these we have planted a variety of bulbs and have been studying their development. Most of them have done remarkably well. Lilium Candidum bulbs attained an enormous size, and Roman Hyacinths made bulbs of such quality, that one New York firm wrote for price for growing a trial order of such quality of 100,000 bulbs, which of course could not be considered by the Station and stock enough is not yet in the hands of growers here. Gladioli and Roman Hyacinths can both be grown here of superior quality and at a profit. Narcissus of some varieties have done well, but the past hard winter destroyed all those of the Polyanthus class. Our warm autumns cause these to start into growth and the cold kills them. Some of them kept until last of January and then planted, did well. These will all succeed if not planted until after Christmas, so that they will remain dormant until the weather is favorable for their development. Our surplus offsets were all put in the hands of a bulb grower in Pender County for further trial, and we hope to get the industry established here.

Propagation of Hardy Roses.

The fact that in our climate cuttings of the Hybrid Perpetual class of roses root readily when put in the open ground in the fall, like grape cuttings, can be made of great importance to our people. Northern florists are obliged to propagate them at a greater expense under glass. One of the leading New York florists sent us last fall some thousands of cuttings for trial. Unfortunately, the cuttings were from imported plants grown in the moist climate of England, and the wood was not firm and ripe enough for the best results. The very severe weather coming soon after was very destructive to many of the unripe cuttings. But from those which survived we now have strong bushes from four to six feet high. At the prices which these roses command at wholesale, their propagation ought to be a very sim-

ple and profitable matter. It will be necessary, however, to have a plantation of stock plants growing here for cuttings. With home grown wood ripened in our sunny autumns, there need be hardly one per cent. of loss in rooting these roses. Experiments made two years ago with our own wood demonstrate this. We will experiment further this winter.

IV. ACKNOWLEDGMENTS.

Our thanks are due to the following firms and individuals for contributions of seeds or plants: California Agricultural Experiment Station; olives. Louisiana Agricultural Experiment Station; fig cuttings. Maine Agricultural Experiment Station; potatoes. New York Cornell Agricultural Experiment Station; potatoes and tomato seed. Thorburn & Co., New York; seed. W. A. Burpee & Co., Philadelphia; seed and books. W. H. Maule, Philadelphia; seed and books. Johnson & Stokes, Philadelphia; seeds. Geo. Tait's Sons, Norfolk, Va.; seeds. Nichols. Livingston's Sons, New York; blackberry plants. A. L. Barringer, Stophel, N. C.; blackberry plants. E. P. Loftin, Kinston, N C.; Balston grapes. Alexander Seed and Drug Co.; seeds. Pitcher & Manda; plants. Woodberry, Paris, Maine; seeds. Munson, Texas; grapes. Mrs. D. S. Butte, Osten, Fla.; cassava and seeds. J Stone, Allendale, S C.; virulus yams. U. S. Agricultural Department; plants of Arancaria Bidwellü. U. S. Agricultural Department; tree seeds. Cleveland Nursery Co., Virginia; strawberry plants. Bauer Bros., Judsonia, Ark.; strawberry plants. W. T. Hood & Co., Richmond, Va.; strawberry plants.



January 12, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 95.

THE FERTILIZER CONTROL DURING 1893

INCLUDING

THE OFFICIAL ANALYSES OF SPRING AND FALL SAMPLES AND A DESCRIPTION OF INGREDIENTS IN FERTILIZERS AND THEIR ANALYSES.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION,

INCLUDING

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AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

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THE FERTILIZER CONTROL DURING 1893

INCLUDING

THE OFFICIAL ANALYSES OF SPRING AND FALL SAMPLES AND A DESCRIPTION OF INGREDIENTS IN FERTILIZERS AND THEIR ANALYSES.

By H. B. BATTLE, Director.

As has been frequently stated, the work of the Station lies under two heads:

1. The Agricultural Experiment Station.
2. The Fertilizer Control Station.

THE FERTILIZER CONTROL STATION.

The present bulletin is issued in the interest of the latter, and presents to the people of the State the analyses of samples of fertilizers taken both in the spring and fall season of 1893. It is issued before the opening of the spring season of 1894, in order to give the relative standing of all brands of fertilizers sold in the State, so far as they are found and sampled. This bulletin is published before the movement in fertilizers has begun for 1894, with the view of affording to purchasers means of judging of the standing of any given brand during the past seasons.

Analyses for 1894. As is known, the samples of fertilizers are taken by the official inspectors from fertilizers after they have been sent into the State and are out of the hands of manufacturers and in the hands of local dealers. These samples, therefore, represent exactly what the purchasers are getting. Samples are taken throughout the season by the different inspectors in various portions of the State. Analyses are made very promptly upon receipt of samples from the inspectors, and gotten ready for publication with the least possible delay. As in past years, they will be printed every two weeks during the fertilizer season of 1894. These bi-weekly bulletins are sent only to those who request them, but one application only is required for the whole series.

The Present Fertilizer Laws. The following carefully prepared digest shows accurately, in small compass, the existing laws in regard to fertilizers. It is intended to give information in regard to the fertilizer trade which should be known by purchasers, dealers, and the public generally:

DIGEST OF EXISTING FERTILIZER LAWS.

No manipulated guanos, superphosphates, commercial fertilizers or other fertilizing material shall be sold or offered for sale unless a tonnage charge of twenty-five cents per ton has been paid. Each barrel, package or bag shall have attached a tag representing this fact, which tags are issued by the Commissioner of Agriculture according to regulations prescribed by the Department of Agriculture. The Department of Agriculture has power at all times to have samples collected of any fertilizer or fertilizing material on sale, which must be taken from at least ten per cent. of the lot selected. These samples are taken from the goods in the hands of dealers after they are shipped from the manufactories, and accordingly represent the true grade of fertilizers offered for sale.

Every package of fertilizer offered for sale must have thereon a plainly printed label, a copy of which must be filed with the Commissioner of Agriculture, together with a true sample of the fertilizer which it is proposed to sell at or before the shipment of such fertilizer into the State, and which label must be uniformly used and not changed during the year. This label must set forth the name, location and trade mark of the manufacturer, also the chemical composition of contents, and real percentage of the ordinary ingredients (no fertilizers can be sold with a content less than 8 per cent. of available phosphoric acid, 2 per cent. of ammonia and 1 per cent. of potash), together with date of analyzation, and that all charges have been paid. There must be no variation in the guaranteed percentages, but the bags must be branded with the exact chemical composition of the contents.

It is a misdemeanor and a fine of $10 for each bag, for an agent or dealer to offer for sale any such fertilizer or fertilizing materials not properly tagged, or a consumer to remove it, or a railroad agent to deliver it. Goods kept over from last season must be tagged to represent this fact, and all dealers are required to report the amount on hand at the close of the fiscal year on November 30th. The following articles are exempt: Land plaster, agricultural lime, oyster-shell lime, marl, and cotton-seed meal; also materials in bulk, when sent to manufacturers for mixing in fertilizers.

Any fertilizer that is spurious and does not contain ingredients as represented by the label, is liable to seizure, and after being established on trial, its value is recoverable by the Board of Agriculture. Any person who offers for sale fertilizers or fertilizing material without having attached thereto labels as provided by law is liable to a fine of $10 for each separate package, one-half, less the cost, going to the party suing, and the remainder to the Department; and if such fertilizer is condemned, the Department makes analysis of the same and has printed labels giving the true chemical ingredients of the same put on each package, and fixes the commercial value at which it may be sold. The Department of Agriculture can require agents of railroads and steamboat companies to furnish monthly statements of the quantity of fertilizers transported by them. The Experiment Station analyzes samples taken by the official inspectors, and publishes the results when deemed needful.

THE MANUFACTURE OF COMMERCIAL FERTILIZERS.

The term commercial fertilizers can embrace all materials specially prepared for the purpose of applying to the soil as food for plants. The term commercial or artificial fertilizers includes materials used alone as fertilizing applications, or a combination of two or more of these to furnish a more complete fertilizer specially suitable to certain crops. The more valuable constituents of a complete fertilizer are available phosphoric acid, nitrogen (or ammonia) and potash. Where materials contain principally only one of these constituents they are spoken of as fertilizing ingredients. Ingredients are carefully analyzed, their grade ascertained, and are then mixed in the right proportion to secure certain percentages desired.

Complete fertilizers are made either by the wet or dry mixing pro-

cesses, the latter being somewhat preferable and more generally followed than the former. By the dry process all of the ingredients are manipulated, dried and ground before being mixed together. As they are thoroughly dry, the mixing is rapidly and easily accomplished. In the wet process the ingredients, when only partially prepared, are mixed and then treated with sulphuric acid to convert them into a more available state. A larger quantity of acid is used by this plan, somewhat more time is required in the preparation, and more time is consumed in allowing the mass to dry sufficiently to be ground and placed on the market. Some crops require more of one constituent than another, and hence the proportions in a fertilizer must be altered to suit the crop fertilized. This need is modified by the character of the soil used for cultivation, since a soil may contain a larger proportion of one or more of the three valuable ingredients than is usual. A gravelly soil, formed from granite rocks, contains a larger proportion of potash than is usual, while the sandy soils of more recent formations have a marked deficiency. New land and those soils having much organic matter contain a larger percentage of nitrogen and phosphoric acid than after cultivation for a number of years. Both experience and close observation are needed to best determine what class of fertilizers are best adapted to certain soils for particular crops.

Ingredients Used for Making Fertilizers.

Ingredients will be discussed under three heads: those furnishing the three leading constituents, phosphoric acid, nitrogen (or ammonia) and potash respectively.

A. THOSE FURNISHING PHOSPHORIC ACID.

Phosphoric acid is supplied from mineral phosphates; from fossil phosphates; from bone; from basic slag, which is a by-product in the manufacture of iron and steel; and from guano. These are the principal sources, but small amounts of phosphoric acid are also found in some ingredients furnishing nitrogen (ammonia) or potash, such as cotton-seed meal, cotton-seed hull ashes, tobacco stems, tankage, fish scrap, etc.

(1.) *Mineral Phosphates.* These are of true mineral origin occurring in seams and veins of the oldest rocks, such as Canadian Apatite. This product finds its largest use in England and abroad, and but little is manipulated in the United States because of the cheaper fossil deposits in this country. This Apatite contains 40 per cent. phosphoric acid equivalent to 88 per cent. phosphate of lime. Deposits very similar also occur in Norway.

(2.) *Phosphates of Fossil Origin.* Under this head are included the deposits in South Carolina, Florida, North Carolina, and some other Southern States to a limited extent. These deposits are of great value, and range in properties from the soft marly phosphate, the pebble

phosphate and the hard rock phosphate of Florida, the kidney-shaped phosphate and the honey-combed massive phosphate of South Carolina, to the pebble phosphate, the conglomerate phosphate with carbonate of lime and the black nodular phosphate of North Carolina. The percentage of phosphoric acid ranges from 6 to 40 per cent., according to location and deposit. The South Carolina phosphates of commercial importance average from 56 to 60 per cent. of phosphate of lime, containing about 25 to 27 per cent. of phosphoric acid. Raw phosphates ground to an impalpable powder are sometimes met with under the name of *floats*. Abroad other deposits are known—in Spain, France, England, Belgium, Germany, Algeria and the West Indies, in the islands of Navassa, Sombrero, Aruba, Curacoa, and Orchilla.

(3.) *Phosphates from Bone.* Fresh animal bone contains 22.5 per cent. phosphoric acid, equivalent to 49 per cent. phosphate of lime (also called bone phosphate). The bones are ground and manipulated in this form. Bones may likewise be used, after they are ground and charred to a black dust, for the purification of sugar in the process of refining. This material is called bone black. After being used for sugar refining, the waste product is used as a source of phosphoric acid, and carries a large percentage (33 per cent.) of phosphoric acid. Bone ash, obtained by burning bones, contains 35 per cent. phosphoric acid and is also used.

(4.) *Slag Phosphates.* Many iron ores contain an appreciable quantity of phosphorus in their composition. Until lately such ores have not been worked to advantage, but by the new basic process for the manufacture of steel, the phosphorus is eliminated and becomes a most important by-product in steel making. Indeed, in many cases, the phosphorus recovered is of more value than the steel produced. This new material is known as Thomas slag phosphate, basic slag phosphate, or odorless phosphate. This phosphate known in this country, especially under the latter name, contains 23 per cent. of phosphoric acid, and bids fair to become a strong competitor of the fossil phosphates.

(5.) *Phosphates from Guano.* In certain regions, especially in the South Seas, where there is a very limited rain fall, and upon islands remote from civilization, there exist immense numbers of birds. By living year after year at the same place, their droppings are accumulated so that the deposits often are many feet in thickness. These materials are also especially rich in nitrogenous matters, and are oftentimes of great value. Noted deposits are in the Caribbean Sea, in Cuba, Mona Island, Peru, Bolivia. The Peruvian guano is noted the world over.

(6.) *Phosphates from Miscellaneous Sources.* As has been mentioned, phosphates are also derived from ingredients which furnish more particularly nitrogen (or ammonia) and potash. These are cotton-seed meal with 2.50 per cent. phosphoric acid, cotton-seed hull ashes with about 9 per cent., dried fish (fish scrap) with 8 per cent., tankage

with 11 per cent., tobacco stems with the very small proportion of 0.75 per cent., ammonite with 3 per cent, dried blood with 5 per cent.

Acid Phosphate. Some of the ingredients above mentioned are used without further manipulation after they are finely ground. These are, in value in the following order, ground bone (bone meal), slag phosphate, marl phosphate of Florida, floats, and lime phosphate of North Carolina. These decompose slowly in the soil and while their permanent value in successive years is noteworthy, yet for many crops their solution in the soil is not rapid enough for the best results. Their availability can be rendered greater by composting with organic materials.

In order to produce a more ready availability, crude phosphates in their natural state after being ground are treated with sulphuric acid to change the chemical combination to a more soluble one. Much heat is evolved by the chemical action, which assists in the future drying of the material. After dried it is reground and furnishes the *acid phosphate* of the trade. The acid phosphate is used almost exclusively to furnish the phosphoric acid in a complete fertilizer. A large quantity of sulphate of lime (land plaster) is formed as a necessary result in the manipulation with sulphuric acid, and the beneficial results from the use of land plaster are added to those of the acid phosphate. A common belief is that there is a large excess of *acid* in the acid phosphate, presumably from the use of sulphuric acid in the manipulation. This is an error, for the latter acid is entirely consumed in the solution of the phosphate and all of it is combined with the lime contained in it, to form land plaster. Another common error is the supposition that the use of acid phosphate year by year will cause the soil to become acid. This is impossible, for any excess of acid present (and it is acid from phosphoric acid, not from sulphuric acid) will very promptly be neutralized by its action on the soil particles. This action would also be beneficial, for it would be advantageous to decompose these particles and unlock the soil ingredients to the more complete action of the plant. A well recorded experiment in England at the famous Rothamstead Experiment Station, has shown that an annual application of 350 pounds of acid phosphate to the acre for twenty years has been attended with no deterioration of yield.

B. INGREDIENTS FURNISHING NITROGEN (OR AMMONIA).

These ingredients can be classed under three heads: those of a chemical nature, those derived from animal origin, and those derived from vegetable origin.

1. *Chemicals.* Here is included sulphate of ammonia made as a by-product from the manufacture of coal gas, or the distillation of bones to form bone ash or bone black, whereby the ammonia is distilled off and saved. It contains usually 20 per cent. of nitrogen, equivalent to 24 of ammonia. Nitrate of soda is also a valuable

ingredient. Nitrogen in this form is in a very available state. It usually contains 16 per cent. of nitrogen, equivalent to 19.4 per cent. ammonia. There is, however, no ammonia in nitrate soda and the term is only used for convenience. It is procured from Peru and Chili where it occurs mixed in the soil, having been produced by nitrification in those arid regions. The nitrate of potash is also sometimes used, which is the common saltpetre of commerce. It contains 13 per cent. of nitrogen, together with a large percentage (45) of potash.

2. *Ingredients from Animal Origin.* Here are named dried blood with 13 per cent. of nitrogen equivalent to 16 per cent. of ammonia, fish scrap with 10 per cent., tankage with 9 per cent., and azotin with 15 per cent. of ammonia. These two last are refuse from slaughtering and packing houses, the oil extracted from them previous to being dried and ground.

3. *Ingredients from Vegetable Origin.* Include cotton-seed meal (the ground cake after the oil has been expressed from the kernels already extracted from the hulls) with 8.50 per cent. ammonia containing 7 per cent. nitrogen, castor-pomace with 7 per cent. of ammonia, tobacco stems with 1.80 per cent. of ammonia.

C. INGREDIENTS FURNISHING POTASH.

The potash ingredients are not so numerous, and not so widely diffused as those furnishing phosphoric acid and nitrogen. They are derived from potash salts and from organic origin.

1. *Potash Salts.* These are altogether procured from the mines in Germany at Leopoldshall, Stassfurt, and the vicinity. The natural products are kainit with 12 5 per cent. of potash, carnallite with 9.5 per cent, kieserite with 7 5, and sylvinit with 17 per cent. From these crude materials are manufactured sulphate of potash of two grades, 90 and 96 per cent. (containing 50 and 52.7 per cent. of actual potash); double sulphate of potash and magnesia (called also double manure salt) with 27 per cent. potash; muriate of potash of three grades, 90 to 95 per. cent., 80 to 85 per cent., and 70 to 75 per cent., containing 57, 52, and 46 per cent. of actual potash respectively.

2. *Those from Organic Origin.* Under this head can be embraced ashes from wood with 5 to 10 per cent. of actual potash according to the nature of the wood, and from cotton-seed hulls with 20 to 26 per cent. of potash. Tobacco stems, a refuse from smoking and chewing tobacco manufactories, contain from 4 to 8 per cent. of potash. Potash also occurs to a very limited extent in ingredients furnishing nitrogen or phosphoric acid. Cotton-seed meal contains 1.50 per cent. of potash.

Adulterations in Fertilizers.

All materials may be considered adulterations when used to take the place of some higher priced article when the mixture may be deteriorated thereby. Adulterations are generally refuse materials with

little value, and their use is termed very objectionable. Some such materials are wool waste, hair refuse, hoof and horn shavings and leather waste. Wherever adulterations are detected, the amount is ascertained and subtracted from the usual value of the constituents.

Bulky Portions of a Fertilizer.

The question is often asked—what are the other ingredients of a fertilizer not included in the analysis as published, and may not the pure materials mentioned in the analysis be purchased alone, and a great saving in freight effected?

Many have the idea that the remaining portion of the fertilizer is useless and could be thrown aside with advantage, and possibly may have been used for the purpose of adulteration. These ideas are erroneous. Except when very high grade materials are used, and much higher than are needed to secure the required percentages, additions are never made to fertilizers to reduce these percentages. In fact the usual tendency of mixing ingredients to make a complete fertilizer is the unconscious production of a mixture with lower percentages than those sought. The cause of this is, that the ingredients used are bought on a guarantee, which guaranteed amount is seldom exceeded, certainly not by any large proportion; and again that owing to fierce competition the manufacturers must necessarily figure very closely to meet competition, and must use such materials as will enable them to do this, consistent with the reputation of their goods as well as themselves. Very high grade ingredients indicate special preparation undergone and a consequent higher price. This preparation, while necessary for medicinal chemicals and similar uses, is not needed for fertilizing chemicals. Consequently these high grade materials are not often used for fertilizer making, except for particular results.

The following figures are copied from an analysis of an ammoniated fertilizer given in the table of analyses on subsequent pages:

Water		16.30	per cent. or parts per	100
Soluble phosphoric acid	5.94		" "	"
Insoluble phosphoric acid	1.68		" "	"
Reverted phosphoric acid	3.70		" "	"
Total phosphoric acid		11.32	" "	"
Nitrogen		1.97	" "	"
Potash		3.05	" "	"
Total given in analysis		32.64	" "	"
Remaining portion is		67.36	" "	"

This remaining portion, consisting of 67.36 parts per 100, is made up about as follows: (1) *Organic matter*, which holds the gaseous nitrogen and its equivalent in ammonia, or the phosphate and potash when from organic origin. As nitrogen is a gas there must neces-

sarily be some means for preserving it and preventing its escape into the air. Organic matter, derived from animals or plants having this gas as a part of its constitution, is used for this purpose. This material composes the largest proportion of the bulky portion, comprising about 35 per cent. of the fertilizer. (2) *Sulphate of lime*, which has already been stated, was formed in the manufacture of the acid phosphate and was a necessary result of the treatment of sulphuric acid upon phosphatic materials. The sulphate of lime in this case is about 15 per cent. of the fertilizer. (3) *Lime*, combined chemically with the phosphoric acid, also a necessary result in the manufacture of acid phosphate furnishes about 11 per cent. additional. (4) *Sand*, also necessarily resulting from the manufacture of acid phosphate, coming originally from the crude phosphate rock or other phosphate materials. The proportion is small and furnishes only about 3 per cent. (5) *Chemical salts*, sulphates and chlorides (muriates) combined with the potash which has been used, obtained from some potash salts, cotton-seed hull ashes, wood ashes or similar materials. This quantity is variable and may be stated roughly as 5 per cent. (6) *Miscellaneous constituents*, such as necessary compounds holding nitrogen when in the form of chemicals and not from organic origin, and as compounds accompaning the potash salts. Under this head could be placed the remaining percentage.

A summary of the constituent of a fertilizer would therefore approximate:

Water	16.30	parts per 100
Phosphoric acid	11.32	" " "
Nitrogen	1.97	" " "
Potash	3.05	" " "
Organic matter	30.00	" " "
Sulphate of lime	15.00	" " "
Lime (combined with phosphoric acid)	11.00	" " "
Sand	3.00	" " "
Chemical salts	5 00	" " "
Miscellaneous	3.36	" " "
Total	100.00	parts per 100

WHEN ANALYSES OF FERTILIZERS ARE MADE FOR FARMERS.

The Station does not analyze samples of fertilizers for manufacturers or dealers. It discontinued the practice some years ago, taking this action for several reasons. When the fertilizer manufacturing industry was in its infancy in North Carolina, the Station aided them in every laudable way by advice as to formulas, ingredients suitable for mixing, and by making analyses of materials for them. Now the industry has so grown that sufficient knowledge and facilities are at hand to render it unnecessary to continue the assistance formerly so

freely given. Another reason why this has been withdrawn is that it was found that there was a tendency to abuse the privilege, and occasionally samples were sent to the Station and analyzed that did not truly represent the materials sold. In this particular case, use was made of the Station's analysis in what might have been an unlawful purpose.

Analyses are still made for farmers to aid them in preventing fraud in their purchases of fertilizers; and this applies also to fertilizing ingredients such as kainit, cotton-seed meal, chemicals, and the like. These analyses are made upon the following conditions:

1. That the article to be sampled has regularly paid the tonnage charges for inspection. This charge is extremely small in itself, and was instituted for the protection of farmers and others purchasing these materials, and enables the fertilizer control to be sustained. Millions of dollars have been saved over and over again by reason of the operations of this control, and the continual careful oversight of the fertilizer trade. This protection cannot be extended to fertilizers that have not the requisite tags attached to the bags. It is unlawful for dealers to sell bags or any packages of fertilizers not properly tagged, as well as for shipping agents to deliver and consumers to remove them. Such being the case the very fact that these materials are not tagged would indicate that they were unlawfully on the market, and farmers are advised to refuse to deal in such materials.

2. There must be some special reason for thinking the grade below the guarantee. This requirement is necessary, as otherwise the Station would receive so many samples that the analyses of the official samples might be very greatly retarded thereby if all analyses were attempted at the time they were received. The official inspectors are constantly travelling over the State during the fertilizer seasons and they draw samples wherever fertilizers are found. It is preferable that the samples should be drawn by them in the usual operations of the fertilizer control, for they have better facilities and are more thoroughly acquainted with the proper manner of taking them. On account of their official character, analyses of such samples are of far more importance in disputed cases than a sample from a private party. The Station prefers, therefore, that samples should always come through the official inspectors. Nevertheless, where there is some special reason for doubting the purity of a lot of fertilizers, it will make an analysis of a sample if all of the conditions that are named have been observed.

3. The sample must be taken according to forms prescribed by the Station, which can be obtained upon application. This is necessary in order to procure as fair and average a sample as is possible. It can be easily seen that upon the sample depends entirely the value of the analysis. If it is taken carelessly it may not represent the materials on sale, and the analysis may be entirely worthless on account of that fact. After the sample is received the Station can have no means of ascertaining by an examination of it whether it

has been accurately taken or not. It must, therefore, rely for their accuracy solely on the instructions it gives in advance for drawing these samples. In order to be positive as to the sample none should be sent coming from a manufacturer or dealer. It should always be drawn under the personal supervision of the sender. The sampling in every case must be witnessed and signed by two witnesses, stating that all the instructions have been complied with and a fair average sample has been secured representing in their opinion the lot in question. If it is desired by the sender, the name of the brand and manufacturer with the guaranteed percentages may be retained until after the analysis is received by him, but in every case these must be returned to the Station for completion of the records concerning the sample.

The Necessity of Accurate Sampling.

Owing to the nature of the ingredients composing a fertilizer, it often happens that these ingredients do not remain thoroughly mixed. This is caused by the transportation and handling of the bag, whereby the fine and heavy particles (generally of phosphate) separate from the lighter and more bulky portions of organic materials furnishing nitrogen (or ammonia) and potash, such as cotton-seed meal and tobacco stems. The heavy particles, which are at the same time finer, have the tendency to settle towards the bottom, thereby leaving the coarse organic materials at the top. If now a sample be taken from the top of the bag only, it will show by analysis a higher percentage of the nitrogen or potash than would be the case if the whole contents were carefully mixed before the sample was taken. The analysis will also show a lower percentage of phosphoric acid than should be, because a portion of the fine phosphate has already settled towards the bottom, and is not reached in the sampling. The official inspectors obviate this difficulty by the use of a long hollow steel sampling tube which is thrust in from side to side or end to end of the bag. It is then withdrawn bringing out a core of the contents of the bag in the same position as occurring inside. The instructions for sampling as given by the Station, suggests a plan for securing an average sample without the use of this sampling tube.

THE ANALYSIS OF A FERTILIZER AND AN EXPLANATION OF TERMS USED.

The analysis of a fertilizer is made to determine the quantity of each valuable constituent present. No one, by looking at a fertilizer, can tell its grade, and whether the constituents claimed by the manufacturers are really present. This must be done by a careful chemical examination, and this can only be accomplished by competent experts. Anterior to 1877, before the establishment of the Fertilizer Control, there being no restraint upon manufacturers, many fertili-

zers grew to be of hardly any value, and farmers were losing enormous sums annually, with no opportunity of ascertaining the real character of the goods they were buying. The result in the field was oftentimes disastrous, and the planter lost not only the actual amount paid for the fertilizer, but also the prospective yield in his crop. Now this is changed. By the operations of the Fertilizer Control there is no opportunity for the lowest grades of fertilizers to be brought into the State, unless fraudulently. All brands proposed to be put on sale have to be first registered with the actual guaranteed percentages before they can be lawfully sold. Low grade fertilizers are excluded by law. Samples are taken of the goods after they are put on the market, analyzed and published broadcast. If the grade is found to fall materially below the guarantee it is subject to seizure and condemnation. Whenever the grade is deficient, but not materially so to cause condemnation, the analysis is printed so that the public may be warned in the future.

Terms Used in an Analysis.

All figures given in the tables, except the value per ton, are stated in per cents or parts per 100. There are three special constituents which when present give to a fertilizer its value. These are phosphoric acid, nitrogen (or ammonia), and potash. The valuable chemical elements in these constituents are phosphorus, nitrogen and potassium respectively. These constituents are never present as such, but always combined with other compounds, which combination is necessary for their existence in the fertilizer. In fact these terms so often seen, phosphoric acid, nitrogen (or ammonia) and potash, refer to chemical compounds which do not exist as such, and are only used as a convenient method of referring to the ingredients present in a fertilizer and their amounts.

Phosphoric Acid. In what combinations these ingredients occur depend entirely upon the materials used. If the phosphoric acid is derived from the phosphates of fossil origin (South Carolina rock, etc.) as is most often the case, the phosphorus present in them is combined with lime in the form of tricalcium phosphate, or three parts of lime in combination with phosphoric acid. As this is very insoluble in the soil and is not readily taken up by plants, it is treated with sulphuric acid to render it more soluble and available. After this treatment the phosphate contains only one part of lime and more phosphoric acid than before. It is possible for some of the soluble phosphate so made to slowly change back to the original form, but before reaching it an intermediate form may result with more lime than the soluble. This intermediate form is called the *reverted* phosphate, and the quantity present is estimated as so much *reverted phosphoric acid.* In the laboratory estimation, the soluble phosphoric acid is all that is soluble in pure cold water; the reverted phosphoric acid is that soluble in a standard solution of ammonium citrate

according to a standard method of analysis but insoluble in water; and lastly the insoluble phosphoric acid is that which is insoluble both in water as well as in the citrate solution.

The total phosphoric acid present in a fertilizer or fertilizing ingredient is consequently made up of three forms: (1) soluble phosphoric acid, (2) reverted phosphoric acid, and (3) insoluble phosphoric acid. The last form is not considered as available to the plants as are the other two forms. The first two forms combined are often spoken of as the *available phosphoric acid*, and is not a distinct form of phosphoric acid, but is only the collective name of the reverted and soluble forms taken together. The available phosphoric acid is consequently the sum of the soluble and the reverted, or is the difference between the insoluble and the total phosphoric acid. The available phosphoric acid is now valued at 5 cents per pound according to the plan explained further on. Equal values are there given to the soluble and reverted forms. It is very likely that the Station will separate these forms in the near future and accord to the reverted a lower valuation than to the soluble phosphoric acid. The insoluble phosphoric acid is not valued, except in the case of pure bone meal, when a valuation at 3 cents per pound is given to it. This will probably be changed to embrace a range of values according to the fineness of the meal.

Nitrogen (or Ammonia). Nitrogen should always be used to represent compounds of this character. Ammonia is somewhat misleading, for in many cases of organic materials ammonia is not present at all, but nitrogen is present in the form of nitrogenous matters and would be a better basis of value. Ammonia, however, has become to be used so exclusively by the trade to represent these materials that the term cannot now well be dropped. Consequently both nitrogen and ammonia are given. The former is converted to ammonia by multiplying by 1.214. Only nitrogen (ammonia) from the well recognized legitimate sources is valued. Others which are considered as adulterations are not valued. The value given to the former is now 15 cents per pound.

Potash. This constituent does not exist as such but combined as sulphate, muriate (chloride), carbonate, nitrate, or inorganic combination. The potash estimated is that soluble in pure cold water and is valued at 5 cents per pound.

Water. The quantity of moisture present is estimated as a matter of interest to give an indication of the property of the fertilizer, whether dry or wet. It is not used in estimating the commercial value.

Guaranteed Percentages. The percentages guaranteed by the manufacturer are given side by side with the percentages of the various constituents as found by analysis. This facilitates comparison. The commercial value as determined by these guarantees, and the same valuation of constituents as are applied in the analysis are given in the tables side by side with the commercial value as determined by the analysis.

Relative Seaboard Value per ton of Ingredients. For the purpose of a better comparison among the various brands, and to give some idea of their worth, the relative seaboard value of the ingredients per ton are given as determined by the analysis. In the next column is also given, calculated in a similar way, the value of the guaranteed amounts of the constituents. A fuller discussion upon these relative commercial values, how they are calculated, and in what way they are useful will be found in the two following sections.

How the Valuation of Constituents are Determined.

The valuations of the three constituents, available phosphoric acid, ammonia and potash, are intended to give the market price for cash at the seaboard of the ingredients making up a fertilizer. The cash prices for small lots in bags, free on board cars, are intended. These valuations are made up early in January of each year, to run through the spring and fall seasons. It is expected that there will be variations in the market price of the ingredients during the course of the year, but experience has shown that this variation will be slight. This is because fertilizing materials are largely contracted for in advance before the opening of the year, and in many cases a large majority of the fertilizers are already manipulated before the beginning of the season.

The valuation of the constituents are fixed by a careful examination of existing conditions of the trade, the markets at important centres, and from actual quotations given by seaboard manufacturers and dealers upon the various ingredients used for manipulating fertilizers. These quotations are for cash in small lots free on board and bagged.

The valuations for the year 1894 have been fixed at the same rate as for 1893, and are

For available phosphoric acid	5	cents per pound.
For ammonia	15	" "
For potash	5	" "

The analyses hereafter given in this bulletin are calculated at the above rate, which rate will be retained during the coming year, and published in the bi-weekly analyses of fertilizers already mentioned.

How Values per ton are Calculated, and How they can be Utilized by Farmers.

It may be of interest to some to know how ton values are calculated, using the valuations for the constituents just given. The amount or percentage of either of these constituents present in the fertilizers is given by the analysis. This represents parts per 100. The percentage is accordingly multiplied by the valuation per pound to get value per 100 pounds. This is now multiplied by 20 to determine the value per ton (2,000 pounds). This is done for all

three constituents, and the three amounts are added together to arrive at the value per ton.

The following is an example:

Percentage or pounds per 100.	*Per* 100 *lbs.*	*Per ton* (2.000 *lbs.*)
9.64 Available Phos. Acid at 5c per lb.	$0.4820	$ 9.64
2.39 Ammonia at 15c per lb.	.3585	7.17
3.05 Potash at 5c per lb	.1525	3.05
Total value	$0.9950	$19.86

The value per ton as here given represents the market price per ton at the seaboard of the unmixed ingredients. For interior points, railroad freights to those points must be added. To facilitate further comparison, a correct table of freight rates to prominent interior points in North Carolina is inserted on page 52. This table is carefully revised to date from the published rates of the Associated Railways of Virginia and the Carolinas and can be relied upon as accurate. The values per ton represent unmixed ingredients. They show what would be the approximate cost of the ingredients to a farmer in case he bought them himself for mixing. The cost is, as stated, on the basis of cash in small lots (less than five tons) in bags, at the seaboard. By a comparison of these values as given by the Experiment Station, a farmer can see how much he is being charged over and above the actual cost of the raw materials. The manufacturer in addition has to allow for mixing the ingredients, branding the bags, handling, fixed charges, agents' commiss ons, profits, etc., together with freight to the interior point. The cost of mixing, sacking and branding the bags will not vary greatly from $2.60 per ton.

Considering all items, the price of a mixed ammoniated fertilizer at an interior town, ought not to be more than 25 to $33\frac{1}{3}$ per cent. greater than the relative seaboard value per ton of ingredients as given in the tables found by analysis, with, of course, the freight from the seaboard to the interior point added.

In the tables of analyses, where "F" precedes the station number, it indicates that the sample was taken during the fall inspection. All others were sampled during the spring season.

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
7887	Acme Acid Phosphate	Acme Manuf'g Co., Wilmington, N. C	1
7751	Acme Fertilizer	Acme Manuf'g Co., Wilmington, N. C	2
7871 } F 8287 }	Allison & Addison's Acid Phosphate.	Allison & Addison, Richmond, Va	3
7804	Ammoniated Cotton Fertilizer	Navassa Guano Co., Wilmington, N C	4
7749	Ammoniated Soluble Navassa Guano.	Navassa Guano Co., Wilmington, N. C	5
8102	Ammoniated Soluble Navassa Guano for Tobacco.	Navassa Guano Co., Wilmington, N. C	6
7879	Anchor Brand Fertilizer	Allison & Addison, Richmond, Va	7
7878	Anchor Brand Tobacco Fertilizer.	Allison & Addison, Richmond, Va	8
7776	Ashepoo Acid Phosphate	Ashepoo Phos. Co., Charleston, S. C	9
7780 } F 8281 }	Ashepoo Fertilizer	Ashepoo Phos. Co., Charleston, S. C	10
7855	Ashley Acid Phosphate	Ashley Phos. Co., Charleston, S. C	11
8063	Ashley Complete Fertilizer	Ashley Phos. Co., Charleston, S. C	12
7783	Ashley Soluble Guano	Ashley Phos. Co., Charleston, S. C	13
7782 } F 8297 }	Atlantic Acid Phosphate	Atlantic Phos. Co., Charleston, S. C	14
7818	Atlantic Dissolved S. C. Bone	Atlantic Phos. Co., Charleston, S. C	15
F 8279	Atlantic Fertilizer	Atlantic Phos. Co., Charleston, S C	16
7987	Banner Fertilizer	Reidsville Fert. Co., Reidsville, N. C	17
7873 } F 8268 }	Baugh's Animal Bone and Potash Compound.	Baugh & Sons Co., Norfolk, Va	18
8000 } F 8299 }	Baugh's Bone Meal	Baugh & Sons Co., Norfolk, Va	19
7908	Baugh's Dissolved Animal Bone	Baugh & Sons Co., Norfolk, Va	20
8092 } F 8321 }	Baugh's Fertilizer Chemicals	Baugh & Sons Co., Norfolk, Va	21
7872	Baugh's High Grade Dissolved S. C. Rock.	Baugh & Sons Co., Norfolk, Va	22
8090	Baugh's Raw Bone Superphosphate of Lime.	Baugh & Sons Co., Norfolk, Va	23
7918	Baugh's Special Cotton Guano	Baugh & Sons Co., Norfolk, Va	24
7828	Baugh's Special Substitute for Peruvian Guano.	Baugh & Sons Co., Norfolk, Va	25
7931 } F 8274 } F 8309 }	Beef Blood and Bone Fertilizer	S. W. Travers & Co., Richmond, Va	26
7775	Berkeley Dissolved Bone	Berkeley Phos. Co., Charleston, S. C	27
7794	Berkeley Soluble Guano	Berkeley Phos. Co., Charleston, S. C	28
7867	Bradley's Patent Superphosphate of Lime.	Bradley Fertilizer Co., Boston, Mass	29
8111	British Mixture	Slingluff & Co., Baltimore, Md	30
7964	Broad Leaf Tobacco Guano	Reidsville Fert. Co., Reidsville, N. C	31
7943	Capital Cotton Fertilizer	S. W. Travers & Co., Richmond, Va.	32
7885 } F 8290 }	Capital Dissolved S. C. Bone	S. W. Travers & Co., Richmond, Va	33
8020	Capital Tobacco Fertilizer	S. W. Travers & Co., Richmond, Va	34

NOTE 8000.—The total phosphoric acid in pure bone meal is valued at 3 cents per pound.
" F8299.—The total phosphoric acid in pure bone meal is valued at 3 cents per pound.

	Sampled at	Water.	Insoluble Phos. Acid.	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
													$	$
1	Fair Bluff	15.92	2.35	8.56	3.84	12.40	12	---	---	---	---	---	12.00	12.40
2	Lumberton	16.44	1.34	2.14	5.88	8.02	8	2.54	3.08	3	2.68	2½	19.50	19.94
3	Washington	15.48	1.16	9.19	3.79	12.98	12	---	---	---	---	---	12.00	12.98
	Shelby	14.12	1.22	9.30	3.57	12.87		---	---	---	---	---		12.87
4	Mount Olive	16.30	1.68	5.94	3.70	9.64	8	1.97	2.39	2	3.05	2	16.00	19.86
5	Lumberton	17.40	3.36	4.53	4.07	8.60	8	2.25	2.73	2½	2.51	2	17.50	19.30
6	Mt. Airy	15.40	2.60	4.27	4.75	9.02	8	2.39	2.90	2½	2.66	2	17.50	20.38
7	Washington	14.92	1.65	7.23	2.11	9.34	8	2.03	2.46	2	1.86	1½	15.50	18.58
8	Washington	15.68	2.12	6.74	2.82	9.56	8½	2.45	2.97	3	1.39	1½	19.00	19.86
9	Morven	15.53	1.66	7.39	6.19	13.58	10	---	---	---	---	---	10.00	13.58
10	Monroe	14.55	2.56	6.73	2.42	9.15	8	1.87	2.27	2	2.28	1	15.00	18.24
	Charlotte	17.40	2.75	6.87	2.02	8.89		2.01	2.44		1.57			17.78
11	Morven	16.21	1.75	6.75	3.85	10.60	10	---	---	---	2.16	1	11.00	12.76
12	Rockingham	16.06	4.16	4.23	4.09	8.32	8	2.12	2.57	2	1.55	1	15.00	17.58
13	Morven	15.80	3.01	3.61	6.02	9.63	8	1.71	2.08	2½	1.45	1	16.50	17.32
14	Morven	15.91	1.46	8.42	3.67	12.09	10	---	---	---	1.98	1	11.00	14.07
	Shelby	13.12	1.84	9.95	2.04	11.99		---	---	---	1.10	1		13.09
15	Pineville	15.75	1.89	8.55	5.18	13.73	12	---	---	---	---	---	12.00	13.73
16	Shelby	12.95	1.61	7.91	2.10	10.01	8	2.36	2.87	2½	1.21	1	16.50	19.83
17	Greensboro	12.56	1.20	5.03	2.11	7.14	8	1.59	1.93	2	2.18	1	15.00	15.11
18	Elizabeth City	17.54	2.80	6.14	2.36	8.50	8	1.91	2.32	2	2.27	2	16.00	17.73
	Greensboro	17.72	2.90	5.73	3.11	8.84		1.95	2.37		2.16			18.11
19	Mt. Olive	8.27	See	foot	n'te	----	----	3.92	4.76	4	---	---	24.90	27.01
	Greensboro	7.62	"	"	"	---	---	3.86	4.69		---	---		27.42
20	Scotland Neck	10.41	3.72	1.56	11.53	13.09	11	2.84	3.45	3	---	---	20.00	23.44
21	High Point	11.14	5.91	2.56	3.13	5.69	8	1.76	2.14	2	3.95	1	15.00	16.06
		11.23	4.08	3.90	3.56	7.46		1.86	2.26		3.33			17.57
22	Elizabeth City	15.30	1.16	7.96	5.94	13.90	12	---	---	---	---	---	12.00	13.90
23	High Point	18.81	3.12	4.25	4.11	8.36	8	2.07	2.51	2	---	---	14.00	15.89
24	Pittsboro	15.84	4.25	5.25	3.45	8.70	8	1.78	2.16	2	---	---	14.00	15.18
25	Elizabeth City	9.90	2.39	5.78	3.01	8.79	8	4.54	5.51	5	5.31	5	28.00	30.63
26	Sanford	11.68	1.89	5.88	2.98	8.86	8	1.78	2.16	2	1.91	1	15.00	17.25
	Statesville	13.08	.69	6.23	2.57	8.80		1.49	1.81		1.60			15.83
	Liberty	13.64	1.41	5.90	2.17	8.07		1.75	2.12		1.56			15.99
27	Monroe	16.95	1.96	8.96	3.27	12.23	12	---	---	---	---	---	12.00	12.23
28	Monroe	14.87	1.82	5.85	4.20	10.05	8	1.99	2.42	2½	1.47	1	16.50	18.78
29	Wilmington	16.60	2.34	6.41	2.71	9.12	9	2.02	2.45	2¼	1.30	1	16.75	17.77
30	Roxboro	13.74	0.93	6.98	1.71	8.69	8	1.87	2.27	2	2.14	2	16.00	17.64
31	Greensboro	11.04	2.93	5.88	2.40	8.28	8	1.78	2.16	2	3.54	2	16.00	18.30
32	Louisburg	12.87	0.87	6.28	2.24	8.52	8	1.83	2.22	2	2.30	2	16.00	17.48
33	Dudley	13.43	0.74	7.97	3.75	11.72	10	---	---	---	---	---	10.00	11.72
	Statesville	14.59	2.16	8.19	2.63	10.82		---	---	---	---	---		10.82
34	Greenville	13.35	0.40	5.58	4.24	9.82	8	2.99	3.63	4	3.05	3	23.00	23.76

21.50 per cent. is guaranteed, and 21.21 per cent. is found.

21.50 per cent. is guaranteed, and 22.25 per cent. is found.

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
7884	Carolina Acid Phosphate	F. S. Royster, Tarboro, N. C.	35
7899	Carolina Soluble Bone & Potash	F. S. Royster, Tarboro, N. C.	36
7755 } F 8289 }	Charlotte Acid Phosphate	Charlotte Oil & Fertilizer Co., Charlotte, N. C.	37
7747 } F 8333 }	Charlotte Ammoniated Fertilizer.	Charlotte Oil & Fertilizer Co., Charlotte, N. C.	38
8060	Chesapeake Dissolved Bone Phosphate.	Chesapeake Guano Co., Baltimore, Md	39
7981	Chesapeake Guano	Chesapeake Guano Co., Baltimore, Md	40
F 8329	Chicora Dissolved Bone	Chicora Fertilizer Co., Charleston, S. C	41
F 8285	Climax Dissolved Bone	Caraleigh Phosphate & Fertilizer Co., Raleigh, N. C.	42
F 7798	Cotton Brand Ammoniated Dissolved Bone.	Powers, Gibbs & Co., Wilmington, N.C	43
7758	Cotton Brand High Grade Acid Phosphate, 13 per cent.	Powers, Gibbs & Co., Wilmington, N.C	44
7926	Cotton Brand High Grade Acid Phosphate, 12 per cent.	Powers, Gibbs & Co., Wilmington, N.C	45
7779	Darlington Acid Phosphate	Darlington Phosphate Co., Darlington, S. C.	46
8185 } F 8284 }	Davie & Whittle Acid Phosphate.	Davie & Whittle, Petersburg, Va	47
7906	Diamond Acid Phosphate	E. H. & J. A. Meadows Co., Newbern, N. C.	48
7844 } F 8292 }	Diamond Soluble Bone	Walton & Whann Co., Wilmington, Delaware.	49
7913	Dixie Guano	Rasin Fertilizer Co., Baltimore, Md	50
8091 } F 8298 }	Dundas & Ward's Bone Meal	Dundas & Ward, Jamestown, N. C	51
7756	Durham Acid Phosphate	Durham Fertilizer Co., Durham, N. C	52
7736 } 7768 }	Durham Ammoniat'd Fertilizer	Durham Fertilizer Co., Durham, N. C	53
7860	Durham Ammoniat'd Fertilizer with Peruvian Guano.	Durham Fertilizer Co., Durham, N. C	54
F 8265	Durham Bull Ammoniated Fertilizer.	Durham Fertilizer Co., Durham, N. C	55
8022	Early Trucker for Promoting Quick Growth.	Lazaretto Guano Co., Baltimore, Md.	56
7917	Eclipse Acid Phosphate	Caraleigh Phos. & Fert. Co., Raleigh.	57
7967 } 8157 }	Eclipse Ammoniated Guano	Caraleigh Phosphate and Fertilizer Works, Raleigh, N. C.	58
8126	Edisto Acid Phosphate	Edisto Phosphate Co., Charleston, S. C	59
7774	Edisto Dissolved Bone	Edisto Phosphate Co., Charleston, S. C	60
7859	Edisto Soluble Guano	Edisto Phosphate Co., Charleston, S. C	61
7793	Empire Guano	Rasin Fertilizer Co., Baltimore, Md	62
8065	Etiwan Am'd Superphosphate.	Etiwan Phosphate Co., Charleston, S.C	63
7851	Etiwan Dissolved Bone	Etiwan Phosphate Co., Charleston, S.C	64
7802 } 7941 } F 8282 }	Eureka Acid Phosphate, 10 per cent.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	65

NOTE 8091.—The total Phosphoric Acid in pure bone meal is valued at 3 cents per pound.

" F8298.—The total Phosphoric Acid in pure bone meal is valued at 3 cents per pound.

	Sampled at	Water.	Insoluble Phos. Acid.	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
													$	$
35	Clinton	17.13	0.26	7.70	3.43	11.13	10	...	...	...	...	...	10.00	11.13
36	Kinston	16.60	0.19	6.22	2 72	8.94	8	...	...	...	2.24	2	10.00	11.18
37	Laurinburg	19.12	1.14	7.98	5.46	13.44	13	...	...	...	...	...	13.00	13.44
	Statesville	19.15	0.18	10.82	2.61	13.43		...	...	...	...	...		13.43
38	Lumberton	15.37	0.43	7.27	2.43	9.70	8	2.28	2.77	2½	2.83	1½	17.00	20.84
	Norwood	15.95	0.31	6.83	2.62	9 45		2.36	2.87		1.59			19.65
39	Shelby	15.48	1.30	8.32	5.71	14.03	13	...	...	...	...	...	13.00	14.03
40	Nashville	13.55	1.71	7.05	2.72	9 77	9	1.94	2.36	2¼	1.37	1 4/10	17.15	18 22
41	Mocksville	17.80	1.10	12.73	1.75	14.48	13	...	...	...	...	...	13.00	14.48
42	Greensboro	14.22	3.13	11.35	1.75	13.10	13	...	...	...	...	...	13.00	13.10
43	Wilmington	13.77	1.79	6.65	2.34	8 99	8	1.72	2.09	2	1.91	1	15.00	17.17
44	Goldsboro	17.75	2.34	7.56	5 82	13.38	13	...	...	...	...	...	13.00	13.38
45	Fayetteville	16.55	1.94	8.44	5.11	13.55	12	...	...	...	...	...	12.00	13.55
46	Wadesboro	15.77	3.03	6.67	3.62	10.29	10	...	...	...	1.80	1	11.00	12.09
47	Graham	10.71	3.48	7.19	5.21	12.40	12	...	...	...	...	...	12.00	12.40
	Greensboro	10 66	2.02	7.52	4.56	12.08		...	...	...	...	...		12.08
48	Kinston	18.01	0.86	7 48	4.77	12.25	13	...	...	...	...	...	13.00	12.25
49	Rutherfordt'n	14.38	1.39	6.32	7.13	13.45	13	...	...	...	...	...	13.00	13.45
	Cherryville	12.79	2.20	9.83	3.59	13.42		...	...	...	...	...		13.42
50	Tarboro	21.20	1.51	6.15	2 09	8.24	8	2.00	2.43	2	1.43	1	15.00	16.96
51	High Point	9.20	see	foot	note	...	...	3.71	4.50	3½	...	...	20 12	25 90
	Greensboro	14.01	see	foot	note	...	...	3.86	4.69		...	...		26.71
52	Laurinburg	17.17	1.42	4 02	9.46	13 48	10	...	...	...	...	...	10.00	13 48
53	Wilmington	19.58	3.88	3.34	3 86	7 20	8	1.69	2.05	2	2.39	1½	15.50	15.74
	Wilson	16.62	3.35	3.45	4.43	7.88		1.74	2.11		1.44			15.65
54	Lauringburg	10.62	1.29	5 81	3.11	8.92	8	2.25	2 73	2½	2.88	2	17.50	19.99
55	Salisbury	12.09	3.67	4.18	3.11	7.29	8	2.05	2.49	2	2.99	1½	15 50	17.75
56	Washington	14.57	0 88	5.12	3.22	8.34	7	3.73	4.53	5	4 40	4	26 00	26.33
57	Pittsboro	16.73	1.37	7.22	6.76	13.98	13	...	...	...	...	...	13 00	13.98
58	Clayton	16.71	1.09	7.34	2.44	9.78	8	1.89	2.29	2½	1.64	1½	17.00	18.29
	Mebane	14.97	1.29	6.10	2.31	8.41		2.44	2 96		1.91			19.20
59	Hickory	15.41	1.52	8.00	3.44	11.44	10½	...	...	...	1.90	1½	12.00	13.34
60	Wadesboro	18.40	1.19	9.95	3.93	13.88	12	...	...	...	...	...	12.00	13.88
61	McFarlan	12.02	5.12	4.80	3.28	8.08	8	1.73	2.10	2	1.44	1	15.00	15.82
62	Monroe	17.95	2 24	5.16	2.99	8.15	8	2.25	2.73	2.43	1.96	1½	16.79	18.30
63	Rutherfordt'n	10.53	3.81	5.69	4.41	10.10	8	2.08	2.53	2	1.39	1	15.00	19.08
64	Wadesboro	13.86	1.80	8.85	4.71	13.56	13	...	...	...	...	...	13.00	13.56
65	Mt. Olive	13.74	2.56	7.59	3.82	11.41	10	...	...	...	...	...	10.00	11.41
	Siler City	12.05	1 85	7.22	4 84	12.06		...	...	...	...	...		12.06
	Hickory	10.89	3.95	6.58	5.14	11.72		...	...		...			11.72

16.03 per cent. is guaranteed, and 20.66 found.

16.03 per cent. is guaranteed, and 21.06 found.

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
7806) F 8319)	Eureka Ammoniated Bone Superphosphate.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	66
7977) 8144)	Eureka Ammoniated Bone Superphosphate for Tobacco.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	67
F 8294	Eureka Bone and Potash Compound.	Atlantic and Virginia Fertilizing Co., Richmond, Va.	68
7846) F 8303)	Excellent Georgia Standard Guano.	Wilcox & Gibbs Guano Co., Charleston, S. C.	69
7865	Excellenza Soluble Guano	John S. Reese & Co., Baltimore, Md.	70
F 8293	Excelsior Acid Phosphate	Walton & Whann Co., Wilmington, Del.	71
7764	Farmers Bone Fertilizer	F. S. Royster, Tarboro, N. C	72
7826) F 8280)	Farmers' Friend Fertilizer	Old Dominion Guano Co., Norfolk, Va	73
7822	Fish Scrap	Dey & Bro., Beaufort, N. C	74
8132	Game Guano	Baltimore Guano Co., Baltimore, Md.	75
7752) 7998)	Gem Fertilizer	Acme M'f'g Co., Wilmington, N. C	76
7739	Gibbs & Co.'s High Grade Ammoniated Phosphate.	Powers, Gibbs & Co., Wimington, N.C	77
8182	Gold Dust Guano	Holmes & Dawson, Norfolk, Va	78
F 8331	Great Wheat and Corn Grower	Durham Fertilizer Co., Durham, N. C	79
8029) F 8300)	Griffith's Double Bone Phosphate.	Durham Fertilizer Co., Durham, N. C	80
7792	High Grade Premium Guano	George L. Arps & Co., Norfolk, Va	81
8044	Honest Dollar Pure Bone Phosphate.	Wooldridge Fertilizer Co., Baltimore, Md.	82
7928) F 8295)	Imperial Acid Phosphate	Imperial Fertilizer Co., Charleston, S.C	83
F 8272	Imperial Ammoniated Fertilizer.	Imperial Fertilizer Co., Charleston, S.C	84
7900	Imperial Cotton Grower	Imperial Guano Co., Norfolk, Va	85
8027	Imperial Dissolved Bone	Imperial Fertilizer Co., Charleston, S.C	86
8125	Imperial Dissolved Bone Phosphate.	Clement, Carrington & Co., Lynchburg, Va.	87
7979) F 8271)	Imperial Soluble Guano	Imperial Fertilizer Co., Charleston, S.C	88
7852	Kainit	Darlington Phosphate Co., Darlington, S. C.	89
7761	Kainit, Genuine German	Baugh & Son's Co., Norfolk, Va	90
7823	Kainit, Genuine German	H. Weil & Bro., Goldsboro, N. C	91
7864	Kainit, Genuine German	Chicora Fertilizer Co., Charleston, S.C	92
7853	Kainit, Genuine German	Calder Bros., Wilmington, N. C	93
7760	Kainit, Genuine German	E. H. & J. A. Meadows Co., Newbern, N. C.	94
7925	Kainit, Genuine German	Powers, Gibbs & Co., Wilmington, N.C	95
8088	Kainit, Genuine German	American Fertilizing Co., Norfolk, Va.	96
8058	Kainit, Genuine German	Wando Phosphate Co., Charleston, S.C	97
8089	Kainit, Genuine German	Stono Phosphate Co., Charleston, S. C	98
7773	Kainit, Genuine Leopoldshall	Atlantic Phosphate Co., Charleston, S. C.	99
7734	Kainit, German	James T. Riley Co., Wilmington, N. C.	100

	Sampled at	Water.	Insoluble Phos. Acid	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
													$	$
66	Clinton	14.27	1.25	6.84	2.52	9.36	8	1.71	2.08	2	3.00	2	16.00	18.60
	Elkin	11.00	3.65	5.77	3.21	8.98		1.82	2.21		2.36			17.97
67	Macon	12.16	1.09	4 16	5.09	9.25	9	1.91	2.32	2½	2.71	2	18.50	18.92
	Advance	13.09	2.10	6 90	3.32	10.22		1.77	2.15		2.37			19.04
68	Greensboro	10.51	2.98	7.38	4.31	11.69	10	---	----	----	1.19	2	12.00	12.88
69	Monroe	12.27	6.96	4.81	3 43	8.24	8	1.67	2.03	2	1.66	1	15.00	15.99
	Liberty	18.09	4.13	1.82	5.65	7.47		1 89	2.29		2.26			16.60
70	Wilmington	20.00	1.14	4.77	6.09	10.86	8½	1.94	2.36	2¼	1.45	$1\frac{2}{10}$	16.45	19.39
71	Waco	12.83	3.56	3.93	7.50	11.43	10	---	----	----	----	----	10.00	11.43
72	Elm City	14.11	0.67	5.69	2 34	8.03	8	2.49	3.02	2	2.70	2	16.00	19.79
73	LaGrange	16 80	1.00	5.41	3.57	8.98	8	1.85	2.25	2	2.72	2	16.00	18.45
	Waco	12.84	1.65	6.43	2.42	8.85		1.76	2.14		2.21			17.48
74	Newbern	11.43	---	---	---	---	----	8.65	10.50	9	---	----	27.00	31.50
75	Kinston	14.39	2.16	5.96	2.55	8.51	8	1.68	2.04	2	2.69	2	16.00	17.32
76	Lumberton	15 27	3.93	5 35	2.13	7 48	8	1.66	2.02	2	2.25	2	16.00	15.79
		12.20	2 62	4.06	4.68	8.74		1 63	1.98		2.28			16.96
77	Fair Bluff	15.51	1.92	6.67	2.25	9.02	8	1.99	2.42	2½	2.11	1	16.50	18.39
78	Plymouth	16.41	1.34	6.61	2 35	8 96	8	1.79	2.17	2	2 05	2	16.00	17.52
79	Concord	12.17	2.85	6.87	3.10	9.97	10	---	----	----	1.57	1½	11.50	11 54
80	Winston	15.14	0.73	8.97	5.27	14.24	12	---	---	----	----	----	12.00	14.24
		14.35	0.75	12.55	1.78	14.33		---	---	---	---	---		14.33
81	Monroe	14.32	1.60	6 70	2.43	9.13	8	1.97	2.39	2	1.94	1½	15.50	18.24
82	Eliz'b'thC'ty	11.60	2.01	5.63	3.61	9.24	8	2.79	3.39	3½	7.28	7	25.50	26.69
83	Fayetteville	15.59	3.04	6.20	4.95	11.15	10	---	----	----	0.97	1	11.00	12.12
	Bushy Creek	16.60	3.17	7.61	2.73	10.34		---	----	----	1.09			11.43
84	Bushy Creek	12.92	5.69	5.64	1.85	7.49	8	2.09	2.54	2½	1.33	1	16.50	16.44
85	Kinston	14 52	1.55	5.12	2.58	7.70	8	2.53	3.07	2	2 20	1½	15.00	19.11
86	Concord	12.33	3.06	7.00	5.70	12.70	12	---	----	----	----	----	12.00	12.70
87	Roxboro	14.13	1.07	8.24	5.72	13.96	13½	---	----	----	----	----	13.50	13.96
88	Nashville	12.49	4.64	6.29	2 67	8.96	8	1.94	2.36	2	1.38	1	15.00	17.42
	Lincolnton	14.73	4.29	7.52	1.62	9.14		1.95	2.37		1.38			17.63
89	Wadesboro	6.00	---	----	---	---	---	---	----	----	13.18	12	12.00	13.18
90	Newbern	6 97	---	----	---	---	----	---	----	---	12.78	12	12.00	12.78
91	Newbern	8 66	---	---	---	----	---	---	----	----	13.12	12	12.00	13.12
92	Wilmington	5.40	---	----	---	----	----	---	----	----	12.14	12	12.00	12.14
93	Laurinburg	5.67	---	---	---	---	----	---	----	----	12.48	12.43	12.43	12 48
94	Goldsboro	7 24	---	----	---	---	----	---	---	----	12.64	12	12.00	12.64
95	Fayetteville	7.96	---	---	---	----	--	---	----	----	12.28	12.43	12.43	12.28
96	Pineville	4.01	---	---	---	----	---	---	----	----	13.26	12	12.00	13.26
97	Wadesboro	7.21	---	----	---	----	--	---	----	----	12.46	10	10.00	12.46
98	Pineville	5.35	---	---	--	----	----	---	---	---	12.58	11.89	11.89	12.58
99	Morven	7.58	---	----	---	---	--	---	----	----	12.58	12	12.00	12.58
100	Wilmington	6.64	---	---	---	----	--	---	---	----	13.52	12	12.00	13.52

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
7907	Kainit, German	Davie & Whittle, Petersburg, Va	101
7745	Kainit, German	Durham Fertilizer Co., Durham, N. C	102
8122	Kainit, German	Tygert-Allen Fertilizer Co., Philadelphia, Pa.	103
7733	Kainit, Pure German	R. N. Sweet, Wilmington, N. C	104
8046	Kangaroo Komplete Kompo'nd	Wooldridge Fertilizer Co., Balt., Md.	105
7741	Latimer's Cotton Fertilizer	Acme M'f'g Co., Wilmington, N. C	106
7968	Latta & Mvatt's Special	Chesapeake Guano Co., Baltimore, Md	107
8016	Lazaretto Acid Phosphate	Lazaretto Guano Co., Baltimore, Md.	108
8154	Lazaretto Crop Grower	Lazaretto Guano Co., Baltimore, Md.	109
8152	Lazaretto Special Tobacco Fertilizer.	Lazaretto Guano Co., Baltimore, Md	110
7944	Lee Brand Fertilizer	Jas. G. Tinsley & Co., Richmond, Va.	111
7854	Lee's Prepared Agricultural Lime.	A. S. Lee, Richmond, Va	112
8030	Liebig's High Grade Acid Phosphate.	Liebig Manufacturing Co., Carteret, N. J.	113
7754	Lister's Ammoniated Dissolved Bone Phosphate, 1 per cent.	Lister's Agricultural Chemical Works, Newark, N. J.	114
7945	Lister's Ammoniated Dissolved Bone Phosphate, 2 per cent.	Lister's Agricultural Chemical Works, Newark, N. J.	115
F 8270	Lister's Success Fertilizer	Lister's Agricultural Chemical Works. Newark, N. J.	116
7874	Meadows' Cotton Guano	E. H. & J. A. Meadows Co., Newbern, N. C.	117
7825	Meadows' Special Guano for All Crops.	E. H. & J. A. Meadows Co., Newbern. N. C.	118
7824	Meadows' Special Potato Guano	E. H. & J. A. Meadows Co., Newbern. N. C.	119
8155	Miller & Co's Ammoniated Dissolved Bone Phosphate.	Newark Chemical Works, Newark. N. J.	120
8123	Mt. Airy S. C. Bone Phosphate	Mt. Airy M'f'g Co., Baltimore, Md.	121
7808 F 8275 F 8310	National Fertilizer	S. W. Travers & Co., Richmond, Va.	122
8104	National Special Tobacco Fertilizer.	S. W. Travers & Co., Richmond, Va.	123
7743 7895 F 8288	Navassa Acid Phosphate	Navassa Guano Co., Wilmington, N. C	124
8103 F 8273	Navassa Grain Fertilizer	Navassa Guano Co., Wilmington, N. C	125
F 8283	N. C. Official Farmer's Alliance Acid Phosphate.	Durham Fertilizer Co., Durham, N. C	126
7766 7963 8015 F 8264	N. C. Official Farmers' Alliance Guano.	Durham Fertilizer Co., Durham, N. C	127
8059	Nitrate of Soda	Durham Fertilizer Co., Durham. N. C	128
8131	Ober's Special Compound for Tobacco.	G. Ober & Sons Co., Baltimore, Md.	129

NOTE.—7854 Claims 5 per cent. soda; 6.09 found. Is not classed among regular fertilizers,

	Sampled at	Water.	Insoluble Phos. Acid.	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaran-teed.		Found.	Guaran-teed.	Found.	Guaran-teed.	Guaran-teed.	Found.
													$	$
101	Scotl'd N'ck	7.36	...	....	...	....	....	....	....	...	12.94	12.43	12.43	12.94
102	Lumberton	7.21	...	...	...	....	....	....	....	..	12.60	12	12.00	12.60
103	Newbern	6.99	...	....	..	....	..	....	....	...	12.12	12.43	12.43	12.12
104	Wilmington	6.04	...	...	....	....	...	....	..	....	13.71	12.43	12.43	13.71
105	Eliz'b'th Cit.	12.91	3.12	2.96	5.10	8.06	8	1.84	2.23	2	2.38	2	16.00	17.13
106	Fair Bluff	15.20	1.56	4.83	3.60	8 43	8	2.01	2.44	2½	3.04	2	17.50	18.79
107	Raleigh	15.51	2.06	6.47	2.92	9.39	10	1.79	2.17	2 6/10	1.39	1.18	18.98	17.29
108	Washington	15.45	0.97	8.29	5.99	14.28	13	....	...	....	....	....	13.00	14.28
109	Greenville	14.34	1.69	6.18	3.02	9.20	9	1.90	2.31	2	2.16	1	16.00	18.29
110	Greenville	15.23	1.32	6.55	2.75	9.30	9	2.38	2.89	3	3.21	3	21.00	21.18
111	Louisburg	11.71	1.14	5.68	2.34	8.02	8	1.95	2.37	2	2.35	2	16.00	17.48
112	Laurinburg	13.88	...	....	....	....	....	....	...	....	2.25	2	See	note.
113	Winston	13.50	1.00	7.73	6.48	14.21	13	....	...	....	....	....	13.00	14.21
114	Lumberton	22.37	2.01	5.42	4.35	9.77	8	1.84	2.23	2	2.11	1	15.00	18.57
115	Franklinton	19.34	2.03	7.15	1.49	8.64	8	2.16	2.62	2½	2.02	2	17.50	18 52
116	Lincolnton	14 21	3.07	5.31	3.47	8.78	8	1.60	1.94	2	2.01	2	16.00	16.61
117	Washington	13.22	1.05	7.38	2.38	9.76	8	2.05	2.49	2¼	2.37	2	16.75	19.60
118	Newbern	14.10	1.30	6.50	2.59	9.09	9	1.99	2.42	2½	3.14	2½	19.00	19.49
119	Washington	11.73	1.09	4.71	3.00	7.71	7	3.64	4.42	5	7.85	8	30.00	28.82
120	Wilson	19.85	2.17	6 43	2.59	9 02	9	1.80	2.19	2¼	2.61	2½	18.25	18.20
121	LaGrange	14.85	1.70	8.81	4.20	13.01	13	...	....	....	....	....	13.00	13.01
122	Goldsboro	13.43	0.96	5.12	3.34	8.46	8	1.77	2.15	2	2.28	2	16.00	17.19
	Statesville	14.90	0 97	7.57	2.22	9.79		1.01	1.23		2.59			16.07
	Liberty	14.57	0.95	7.32	2.13	9.45		1.65	2.00		2.13			17.58
123	Stems	15.04	0.93	5.12	3.06	8.18	8	1.60	1 94	2	2 80	2	16.00	16.80
124	Lumberton	15.70	3.94	6 84	4.74	11.58	12	....	....	....	....	....	12.00	11.58
	Kinston	15.14	2.03	7.87	5.77	13.64		....	....	....	....	...		13.64
	Newton	15.43	3.13	9.10	2.70	11.80		....	...	....	....	...		11 80
125	Mt. Airy	14.05	2.62	5 62	4.11	9.73	8	2.10	2.55	2	2.60	2	16.00	19.98
	Newton	13.79	1.00	6.63	2.12	8.75		2.23	2.71		2 88			19 76
126	Statesville	18.25	0.63	12.08	1.63	13.71	13	....	....	....	....	...	13.00	13.71
127	Greenville	12 71	1.68	6.50	2 27	8.77	8	2.41	2.93	2½	3.86	3	18.50	21.42
	Stems	14.71	1.14	5.53	2.87	8.40		2.06	2.50		2.55			18.45
	Selma	14.37	1.83	5.86	2.69	8.55		1.88	2.28		3.20			18.59
	Statesville	11.51	3.57	4.23	3.01	7.24		2.19	2.66		3.15			18.37
128	Laurinburg	1.64	...	....	...	....	...	15.96	19.38	18	....	...	54 00	58.14
129	Ruffin	14.74	1.73	7.94	1.68	9.62	8	2.08	2.53	2½	4.85	2	17.50	22.06

and same valuations cannot be applied.

Station Number.	Name of Brand.	Name of Manufacturer or, Agent.	
8064 } F 8332 }	Ober's Special Cotton Compo'nd	G. Ober & Son's Co., Baltimore, Md..	130
8130	Ober's Standard Tobacco Fertilizer.	G. Ober & Son's Co., Baltimore, Md..	131
7759 } 7785 } F 8296 }	Old Dominion Dissolved Bone and Potash.	Old Dominion Guano Co., Norfolk, Va	132
7737 } 7771 } F 8320 }	Old Dominion Soluble Guano..	Old Dominion Guano Co., Norfolk, Va	133
7784	Old Dominion Soluble Tobacco Guano.	Old Dominion Guano Co., Norfolk, Va	134
8128	Old Indian Chief Tobacco Guano.	Clement, Carrington & Co., Lynchburg, Va.	135
7978 } F 8266 }	Orient Complete Manure.....	Atlantic & Virginia Fertilizing Co., Richmond, Va.	136
7827	Orinoco Tobacco Guano.....	F. S. Royster, Tarboro, N. C.....	137
7898	Our Acid Phosphate.....	Atlantic and Virginia Fertilizing Co.. Richmond, Va.	138
7946 } F 8267 }	Owl Brand Guano.....	Davie & Whittle, Petersburg, Va....	139
7960	Owl Brand Special Tobacco Guano.	Davie & Whittle, Petersburg, Va....	140
7966 } 8151 }	Owl Brand Tobacco Plant Guano.	Davie & Whittle, Petersburg, Va....	141
7807	Patapsco Guano.....	Patapsco Guano Co., Baltimore, Md..	142
7857	Pee Dee Fertilizer.....	Darlington Phosphate Co., Darlington. S. C.	143
7909	Peruvian Mixture.....	American Fertilizer Company, Norfolk, Va.	144
8017	Piedmont Guano for Tobacco	Mt. Airy M'f'g Co., Baltimore, Md...	145
8007	Piedmont Guano Special Fertilizer.	Mt. Airy M'f'g Co., Baltimore, Md...	146
7735	Pine Island Ammoniated Phosphate.	Quinnipiac Co., New York, N. Y.....	147
7951 } F 8277 }	Plow Brand Raw Bone Superphosphate.	Walton & Whann Co., Wilmington, Del.	148
8129	Pocahontas Special Tobacco Fertilizer.	Clement, Carrington & Co., Lynchburg, Va.	149
7791	Pocomoke Superphosphate....	E. B. Freeman & Co., Norfolk, Va...	150
7795 } 7896 }	Powell's Green Bag Fertilizer for Potatoes.	W. S. Powell & Co., Baltimore, Md..	151
7866	Progressive Farmer Guano....	Durham Fertilizer Co., Durham, N. C	152
7762 } 7769 }	Prolific Cotton Grower.....	Goldsboro Oil Co., Goldsboro, N. C...	153
7809	Prolific Truck Guano.....	Goldsboro Oil Co., Goldsboro, N. C...	154
8045	Quick Step High Grade Acid Phosphate.	Wooldridge Fertilizer Co., Baltimore, Md.	155
7919	Raleigh Standard Guano.....	N. C. Cotton Oil Co., Raleigh, N. C...	156
7778 } F 8318 }	Rasin Acid Phosphate.....	Rasin Fertilizer Co., Baltimore, Md...	157
8028	Reese's Dissolved Bone.....	John S. Reese & Co., Baltimore, Md..	158

	Sampled at	Water.	Insoluble Phos. Acid.	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
													$	$
130	Laurinburg	15.81	2.55	8.21	1.47	9 68	8	2.03	2.46	2	1.91	1 4/10	15.40	18.97
	Concord	13.85	3.39	7.70	2.04	9.74		2.14	2.60		1.41			18.95
131	Milton	13.60	1.99	7.67	1.96	9.63	8	1.77	2.15	2	2.05	1 4/10	15.40	18.13
132	Goldsboro	14.25	0.81	4.66	3.43	8.09	8½	---	----	----	2.74	2	10.50	10.83
	Rockingham	13.49	0.70	4.58	3.39	7.97		---	----	----	2.30			10.27
	Waco	14.03	0.84	6.09	2.84	8.93		---	---	---	2.40			11.33
133	Wilmington	16.05	1.19	5.60	2.41	8.01	8	1.82	2.21	2¼	3.02	2	16.75	17.66
	Goldsboro	15.22	0.97	5.78	2.10	7.88		1.93	2.34		2.63			17.53
	Elkin	14.23	1.39	6.47	2.35	8.82		1.86	2.26		2.30			17.90
134	Apex	13.76	0.92	5.49	2.78	8.27	8¼	2.16	2.62	2¼	3.43	2	17.00	19.56
135	Cuningham	12.51	2.11	5.18	3.62	8.80	8	1.64	1.99	2	2.02	2	16.00	16.79
136	Spring Hope	13.64	1.59	6.22	3.91	10.31	8	2.07	2.51	2	1.10	1	15.00	18.76
	Hickory	13.57	2.42	5.32	3.04	8.36		1.63	1 98		1.47			15.77
137	Greenville	19.41	0.41	6.86	2.21	9 07	8	2.10	2.55	2½	4.24	3	18.50	20.96
138	Kinston	12 79	1.66	8.83	4.32	13.15	12	---	----	----	----	---	12.00	13.15
139	Lumberton	18.40	2.05	7.27	1.89	9.16	8½	1.75	2.12	2	2.08	1¼	15.75	17.60
	Greensboro	10.79	2.39	6.24	3.11	9.35		1.84	2.23		1.27			17.31
140	Creedmore	17.77	1.56	7.51	2.38	9.89	9	2.30	2.79	2 6/10	2.14	1¾	18.55	20.40
141	Mebane	15.82	1.10	6.19	3 51	9 70	9	2.20	2.67	2 6/10	1.90	1¾	18.55	19 61
	Madison	17.60	1.13	7.04	2.41	9.45		2.04	2.48		2.00			18.89
142	Goldsboro	14.55	1.70	6.45	2.79	9.24	9¼	2.03	2.46	2½	2.02	1¼	18.00	18 64
143	Wadesboro	18.35	1.68	4.87	3.36	8.23	8	1.86	2.26	2½	2.08	1	16.50	17.09
144	Scotl'd Neck	14.91	1.10	6.10	2.82	8.92	8	1.83	2.22	2	2.12	1½	15.50	17.70
145	Wilson	11.73	1.97	5.78	3.61	9.39	8	2.05	2.49	2½	3.13	3	18.50	19.99
146	Dunn	11.19	1.57	5.60	3.61	9.21	8	1.77	2.15	2	1.29	1	15.00	16.95
147	Wilmington	17.57	2.56	4.17	4.07	8 24	8	1.74	2.11	2	1.70	1	15.00	16.27
148	Louisburg	15.17	2.96	5.21	5.57	10.78	9	2.13	2.59	2	2.18	1½	16.50	20.73
	Waco	14.26	1.42	7.18	3.99	11.17		1.75	2.12	2½	1.50	1½	18.00	19.03
149	Cuningham	11.83	2.19	5.50	3.57	9.07	9	2.06	2.50	3	3.53	2	19.00	20.10
150	Monroe	13.99	1.83	5.92	3.37	9.29	8½	1.83	2.22	2	2.24	1½	16.00	18.19
151	Jacksonville	13.05	0.40	3.34	1.75	5.09	5	4.40	5.34	6	9.43	8	31.00	30.54
	Kinston	8.70	0.88	6.04	1.32	7.36		4 90	5 95		8.89			34.10
152	Wilmington	18.95	3.53	3.21	4.27	7.48	8	1.69	2 05	2	1.65	1½	15.50	15.28
153	Goldsboro	13.88	2.37	6.70	2.79	9.49	8	2.01	2.44	2½	2.55	2	17.50	19.36
	Kinston	13.55	2.28	6.12	3.10	9.22		2.32	2.82		2.33			20.01
154	Goldsboro	12.49	0.20	5.12	1.91	7.03	7	3.54	4 30	4	8.98	6	25.00	28.91
155	Eliz'beth City	10.79	3.21	3.45	5.65	9.10	8	2.22	2.70	2½	3.53	3	18.50	20.73
156	Apex	12.35	1.39	6.14	3.22	9.36	8	2.47	3 00	2¾	2.03	2	18.25	20.39
157	Morven	14.97	0.15	9.54	4.87	14.41	14	---	----	----	----	---	14.00	14.41
	Reidsville	13.91	0.70	11.77	2.72	14.49		---	----	----	---	---		14.49
158	Winston	18.06	0 54	8.58	3.67	12.25	14	---	----	----	----	----	14.00	12.25

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
7796 } F 8276 }	Reese's Pacific Guano	Jno. S. Reese & Co., Baltimore, Md	159
8053	Reliance Ammoniated Superphosphate.	Walton & Whann Co., Wilmington, Delaware.	160
7969	Richmond Brand Fertilizer	Jas. G. Tinsley & Co., Richmond, Va.	161
7910	Root Crop Fertilizer	Navassa Guano Co., Wilmington, N. C	162
8061	Royal Acid Phosphate	Royal Fertilizer Co., Charleston, S. C.	163
7750	Royal Ammoniated Fertilizer	Royal Fertilizer Co., Charleston, S. C	164
7777	Royal Dissolved Bone	Royal Fertilizer Co., Charleston, S. C.	165
8001	Royal Soluble Guano	Royal Fertilizer Co., Charleston, S. C.	166
7905	Royster's Acid Phosphate	F. S. Royster, Tarboro, N. C	167
7757 } 7933 } F 8302 }	Royster's High Grade Acid Phosphate.	Old Dominion Guano Co., Norfolk, Va	168
7980	Sea Bird Ammoniated Guano.	Powers, Gibbs & Co., Wilmington, N.C	169
7748	Sea Fowl Guano	Wm. L. Bradley, Boston, Mass	170
7947	Sea Gull Ammoniated Guano	Patapsco Guano Co., Baltimore, Md	171
7763	Special Compound for Cotton, Corn, Peanuts, etc.	F. S. Royster, Tarboro, N. C	172
7877	Standard Bone Fertilizer	Tygert-Allen Fertilizer Co., Philadelphia.	173
7738	Standard Fertilizer, Lister's Success.	Lister's Agricultural and Chemical Works, Newark, N. J.	174
8031	Standard Fertilizer	Liebig M'f'g Co., Carteret, N. J	175
8023	Standard Premium Guano	Imperial Guano Co., Norfolk, Va	176
8112	Standard Tobacco Fertilizer	Liebig M'f'g Co., Carteret, N. J	177
8021	Standard Trucker	Imperial Guano Co., Norfolk, Va	178
F 8286	Staple Acid Phosphate	Caraleigh Phosphate & Fertilizer Works, Raleigh, N. C.	179
7915 } F 8269 }	Star Brand Guano	Allison & Addison, Richmond, Va	180
F 8317	Sterling High Grade Acid Phosphate.*	Caraleigh Phosphate & Fertilizer Works, Raleigh, N. C.	181
F 8301	Stonewall Brand Acid Phosphate.	Jas. G. Tinsley & Co., Richmond, Va	182
7883	Stonewall Brand Fertilizer	Jas. G. Tinsley & Co., Richmond, Va.	183
7965 } 8146 }	Stonewall Tobacco Fertilizer	Jas. G. Tinsley & Co., Richmond, Va.	184
7929	Stono Acid Phosphate	Stono Phosphate Works, Charleston, S. C.	185
8062	Stono Complete Fertilizer	Stono Phosphate Works, Charleston, S. C.	186
7843 } 8035 }	Stono Dissolved Bone	Stono Phosphate Works, Charleston, S. C.	187
7753	Stono Soluble Guano	Stono Phosphate Works, Charleston, S. C.	188
7765	Tinsley & Co's Tobacco Fertilizer.	Jas. G. Tinsley & Co., Richmond, Va.	189
7911	Trucker's Delight, High Grade Potato Manure.	F. S. Royster, Tarboro, N. C	190
7912	Truck Guano	Rasin Fertilizer Co., Baltimore, Md	191

* The manufacturers claim that 13 per cent. sacks were used by error for 12 per cent. sacks.

	Sampled at	Water.	Insoluble Phos. Acid.	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
													$	$
159	Wilmington	21.31	1.16	1.47	8.46	9.93	8½	1.89	2.29	2¼	2.25	1 2/10	16.45	19.05
	Salisbury	17.23	1.18	4.16	4.55	8.71		2.02	2.45		2.27			18.33
160	Fayetteville	11.47	3.66	3.28	5.35	8.63	8	1.67	2.03	2	2.00	1	15.00	16.72
161	Clayton	11.33	0.99	6 03	2.56	8.59	8	1.77	2.15	2	1.29	1	15.00	16.33
162	Kinston	11.64	1.30	5.07	1.93	7.00	7	4.35	5.28	5	7.30	7	29.00	30.14
163	Wadesboro	15 57	1.82	7.93	3.20	11.13	10	....	....	....	1.52	1	11.00	12.65
164	Lumberton	17.23	1.88	6.54	2.97	9.51	8¾	2.04	2.48	2½	1.41	1	17.25	18.36
165	Monroe	12.96	2.17	6.91	5.73	12.64	12	....	....	....	....	....	12.00	12.64
166	Mt. Olive	15.31	1.37	6.56	2.84	9.40	8	1.96	2.38	2	1.42	1	15 00	17.96
167	Tarboro	14.50	0.43	8.32	5.63	13.95	13	....	....	....	....	....	13.00	13.95
168	Kinston	12.90	1.41	8.74	2.23	10.97	12	....	....	....	....	....	12.00	10.97
	Carthage	16.14	0.64	9.52	4.50	14.02		....	....	....	....	....		14.02
	Mt. Airy	11.14	1.68	7.80	4.64	12.44		....	....	....	....	....		12.44
169	Nashville	13 90	0.96	7.00	3.11	10.11	8	2.01	2.44	2½	1.60	1	16.50	19.03
170	Lumberton	21 32	1.51	6.33	3.57	9.90	9	2.01	2 44	2¼	1.46	1	16.75	18.68
171	Louisburg	14.90	1.89	6.33	3.23	9.56	9	1.84	2.23	2	2.04	1½	16.50	18.29
172	Elm City	18 82	0.20	5 81	3.39	9.20	8	1.70	2.06	2	2.70	1½	15.50	18.08
173	Edenton	13.79	1.62	6.27	2.73	9.00	8	1.77	2.15	2	2.60	2	16.00	18.05
174	Wilmington	18 47	2 90	6.73	2.00	8.73	8	1.85	2.25	2	2.66	2	16.00	18.14
175	Winston	21.98	1.83	2.17	7.51	9.68	8	1.58	1.92	2	3.52	2	16.00	18 96
176	Washington	9.81	2 52	3.42	4.10	7.52	8	1.76	2.14	2	1.60	1½	15.50	15.54
177	Roxboro	19.46	1.55	2.47	7.40	9.87	8	1.72	2.09	2¼	2.91	2¼	17.00	19.05
178	Washington	14.35	1.09	5.32	3.58	8.90	8	4.18	5.07	5	5.14	4	27.00	29.25
179	Statesville	15.48	3.85	9.86	2.64	12.50	10	....	....	....	....	....	10.00	12.50
180	Scotland Neck	17.12	1.45	6.91	2 22	9.13	8	1.87	2.27	2	1.89	1¼	15 25	17 83
	Shelby	16.84	1.66	7.01	1.80	8.84		1.96	2.38		1.54			17.52
181	Asheboro	15.33	3.93	10.53	1.57	12.10	13	....	....	....	....	....	13.00	12.10
182	Winston	13.01	1.82	6.91	3.19	10.10	10	....	....	....	....	....	10.00	10.10
183	Rockingham	12.61	0.84	6.56	2.55	9.11	8	1.73	2.10	2	2.19	2	16.00	17.60
184	Hillsboro	10.92	1.16	5.50	3.10	8.60	8	1.75	2.12	2	2.30	2	16.00	17.26
	Pilot Mount'n	14.29	0.68	6.52	2.25	8.77		1.65	2.00		2.34			17.11
185	Fayetteville	14.45	1.88	7.42	3.62	11.04	10	....	....	....	1.71	1	11.00	12.75
186	Polkton	17.88	2.97	7.10	2.08	9.18	8	2.09	2.54	2	1.92	1	15.00	18.72
187	Monroe	15.00	2.05	7.22	4.73	11.95	12	....	....	....	....	....	12.00	11.95
	Davidson Col.	15.63	2.12	8 29	3.87	12.16		....	....	....	....	....		12.16
188	Lumberton	17.00	4.14	6.08	2.65	8.73	8	2.11	2.56	2½	1.41	1	16.50	17.82
189	Wilson	12.14	0.75	6.28	3 31	9.59	8	3.30	4.01	4	3.10	2½	22.50	24.72
190	Tarboro	17.34	0.26	6 73	2.17	8.90	8	2.85	3.46	4	3.97	4	24.00	23.25
191	Tarboro	13.15	1.85	6.98	2.17	9.15	7	3.37	4 09	4	2.64	2	21.00	24.06

Station Number.	Name of Brand.	Name of Manufacturer or Agent.	
7829	Trucker's Phosphate	Wm. R. Griffith, Baltimore, Md	192
7875	Trucker's Special Potato Guano	Wilcox & Gibbs' Guano Co., Charleston, S. C.	193
8124	Tygert-Allen Co.'s Acidulated Phosphate.	Tygert-Allen Fert. Co., Philadelphia, Pa.	194
8153	Vegetable Compound	Lorentz & Rittler, Baltimore, Md	195
8113 } 8145 }	Vinco Guano for Tobacco	Davie & Whittle, Petersburg, Va	196
7942	Wagener & Co.'s High Grade Ammoniated Fertilizer.	F. W. Wagener & Co., Charleston, S. C	197
7849	Walker's Ammoniated Phosphate.	Joshua Walker, Baltimore, Md	198
7817 } F 8291 }	Wando Acid Phosphate	Wando Phosphate Co., Charleston, S.C	199
F 8330	Wando Dissolved Bone	Wando Phosphate Co., Charleston. S.C	200
7740 } F 8278 }	Wando Soluble Guano	Wando Phosphate Co., Charleston, S.C	201
8018	Wells' Ammoniated Dissolved Bone Phosphate.	Durham Fertilizer Co., Durham, N. C	202
7816	Wilcox & Gibbs' High Grade Acid Phosphate.	Wilcox & Gibbs' Guano Co., Charleston, S. C.	203
7742 } 7876 }	Wilcox, Gibbs & Co.'s Manipulated Guano.	Wilcox & Gibbs' Guano Co., Charleston, S. C.	204
7946	Yancey's Formula for Tobacco	Boykin, Carmer & Co., Baltimore, Md	205
8019	Zell's Ammoniated Bone Superphosphate.	Zell Guano Co., Baltimore, Md	206

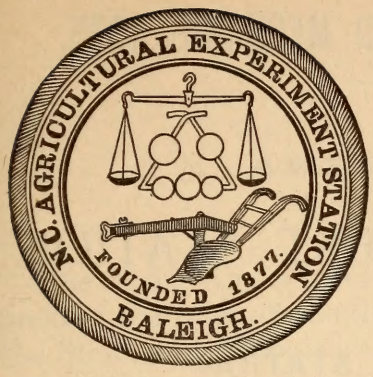
	Sampled at	Water.	Insoluble Phos. Acid.	Soluble Phos. Acid.	Reverted Phos. Acid.	Avail. Phos. Acid.		Nitrogen.	Equivalent to Ammonia.		Potash.		Relative Seaboard Value per ton of Ingredients.	
						Found.	Guaranteed.		Found.	Guaranteed.	Found.	Guaranteed.	Guaranteed.	Found.
													$	$
192	Elizab'th City	10.50	3.06	4.41	2.59	7.00	5½	3.79	4.60	4½	3.06	2	21.00	23.86
193	Washington	14.13	0.46	6.86	0.85	7.71	7	2.98	3.62	4	4.87	4	23.00	23.44
194	Newbern	13.98	1.77	8.74	5.53	14.27	14	...	...	...	...	...	14.00	14 27
195	Washington	10.23	2.71	3.86	3.14	7.00	7	5.12	6.22	8	4.65	4	35.00	30.31
196	Roxboro	16.65	1.37	6.24	2.62	8.86	8½	1.72	2.09	2	1.55	1¼	15.75	16.68
	Pilot Mount'n	20 27	1 16	2.64	6.59	9.23		1.77	2.15		1.44			17.12
197	Morven	13.07	2.62	7.30	2.02	9.32	8	2.17	2.63	2½	1.23	1	16.50	18.44
198	Red Springs	17.91	2 53	4.61	3.87	8.48	8	2.21	2.68	2.43	1.88	1½	16.79	18 40
199	Waxhaw	13.65	2.47	9.42	4.02	13.44	11½	...	...	...	...	...	11.50	13.44
	Lincolnton	14.09	2.72	10.81	2.31	13.12		...	...	...	...	...		13.12
200	Concord	14.84	2.56	8.38	2.54	10.92	10	...	...	...	2.31	1½	11.50	13.23
201	Fair Bluff	13.81	3.15	7.10	2.80	9 90	9	1.91	2.32	2¼	2.03	1½	17.25	18.89
	Cherryville	12.59	2.81	7.64	2.91	10.55		1.89	2.29		1.49			18.91
202	Wilson	17.18	3.34	2.61	5.42	8.03	8	1.74	2.11	2	1.58	1½	15.50	15.94
203	Waxhaw	13.92	2.15	7.54	6.15	13.69	13	...	...	...	...	...	13.00	13.69
204	Fair Bluff	15.22	2.96	4.45	3.26	7.71	8	2.06	2 50	2½	2 47	2	17.50	17.68
	Washington	13.97	2.65	5.23	3.11	8.34		2 03	2.46		2.73			18.45
205	Henderson	12.89	0.61	7.27	2.64	9.91	8	2.74	3 33	3	2.55	2	19.00	22 45
206	Wilson	16.43	1.38	6.69	3.83	10.52	8	1.73	2.10	2	1.78	1	15 00	18.60

FREIGHT RATES FROM THE SEABOARD TO INTERIOR POINTS.

CORRECTED TO JANUARY 12, 1894, FROM THE PUBLISHED RATES OF THE ASSOCIATED RAILWAYS OF VIRGINIA AND THE CAROLINAS.

In Car loads, of not less than 10 *tons each, per ton of* 2,000 *pounds. Less than Car load, add* 20 *per cent.*

DESTINATION.	From Wilmington, N.C.	From Norfolk and Portsmouth, Va.	From Charleston, S.C	From Richmond, Va
Asheville	$ 4 00	$ 4 60	$ 4 60	$ 4 00
Chapel Hill	3 20	3 80	4 40	3 20
Charlotte	3 00	3 20	3 20	3 20
Clayton	2 70	3 60	4 20	3 00
Dallas	3 40	4 00	3 40	3 50
Davidson College	3 90	4 50	4 40	3 90
Dunn	2 40	3 00	3 95	3 00
Durham	3 00	3 00	4 20	3 00
Elm City	2 40	2 90	3 90	2 90
Fair Bluff	2 10	3 80	2 85	3 80
Fayetteville	1 60	3 00	3 00	3 00
Forestville	3 30	3 00	4 30	3 00
Gastonia	3 40	4 10	3 40	3 60
Gibson's	2 70	4 00	2 70	4 00
Goldsboro	2 10	3 00	3 65	3 00
Greensboro	3 00	3 00	3 80	3 00
Hamlet	2 70	3 20	4 00	3 20
Henderson	3 30	3 00	4 30	3 00
Hickory	4 00	4 60	4 60	4 00
Kernersville	3 40	3 60	4 20	3 00
Kinston	2 20	2 50	3 75	2 50
Laurel Hill	2 60	3 80	4 00	3 80
Laurinburg	2 30	3 80	4 00	3 80
Liberty	2 50	3 60	3 80	3 60
Louisburg	3 30	3 00	4 30	3 00
Lumberton	2 20	3 80	3 70	3 80
Madison	3 00	3 00	4 20	3 00
Matthews	3 00	3 20	3 20	3 20
Maxton	2 20	3 80	3 50	3 80
Monroe	3 00	3 20	3 20	3 20
Morven	2 70	3 85	2 70	3 85
Mount Airy	3 20	3 50	4 20	3 50
Newbern	2 40	3 30	3 95	3 30
Oxford	3 50	3 60	4 50	3 00
Pineville	3 20	3 95	3 20	3 45
Pittsboro	2 70	3 30	4 40	3 30
Raleigh	2 70	3 00	4 20	3 00
Reidsville	3 75	3 00	4 50	2 40
Rockingham	2 70	3 20	4 00	3 20
Rocky Mount	2 40	3 00	3 95	2 90
Rural Hall	3 20	3 20	4 40	3 20
Rutherfordton	3 40	3 65	3 40	3 65
Salisbury	3 50	3 80	4 20	3 20
Sanford	2 20	3 00	3 80	3 00
Selma	2 40	3 00	3 95	3 00
Shelby	3 40	3 60	3 40	3 60
Siler City	2 40	3 60	3 80	3 60
Smithfield	2 40	3 00	3 95	3 00
Statesville	3 20	3 80	4 40	3 20
Tarboro	2 00	2 00	3 55	2 50
Wadesboro	2 70	3 20	2 70	3 20
Walnut Cove	3 00	3 00	4 20	3 00
Warsaw	2 00	3 20	3 55	3 20
Weldon	2 45	2 00	4 00	2 00
Wilson	2 40	2 90	3 90	2 90
Winston-Salem	3 00	3 00	4 20	3 00



January 20, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 96.

MISCELLANEOUS AGRICULTURAL TOPICS

CONTAINED IN

THE PRESS SERVICE BULLETINS.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURAL AND MECHANIC ARTS.

THE NORTH CAROLINA

AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

BOARD OF TRUSTEES OF THE A. AND M. COLLEGE.

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F. E. EMERY, M. S.....Agriculturist.
GERALD MCCARTHY, B. SC.....Botanist and Entomologist.
W. F. MASSEY, C. E.....Horticulturist.
C. F. VON HERRMANN (U. S. Weather Bureau).....Meteorologist.
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C. B. WILLIAMS, B. S.....Assistant Chemist.
ALEXANDER RHODES.....Assistant Horticulturist.
ROSCOE NUNN (U. S. Weather Bureau).....Assistant Meteorologist.
A. F. BOWEN.....Secretary.

RALEIGH, N. C.

PREFACE.

The N. C. Agricultural Experiment Station on May 24, 1890, commenced the plan of sending Press Bulletins to the various newspapers of the State, and agricultural journals in the United States, with the view of presenting short concise reading notices and articles concerning the investigations of the Station and kindred subjects. The plan at once became very popular, and seemed to supply a link in the dissemination of the work of the Station to the people for whom it was intended, which before was to some degree wanting. Farmers read their home papers, and these short statements would fall under their eye, and their interest would be aroused. The first beneficial result from the use of these articles was in the largely increased number of request for bulletins, not only from North Carolina, but from almost every other State and many foreign countries as well. The Station correspondence was in the same measure enlarged, and it was evident that the citizens of the State were making use of what was offered to them far more than ever before. Nor has this decreased.

In continuation of the plan of the Press Bulletins above outlined and being guided by the experience gained by its operations, the Experiment Station instituted the Press Service Bulletin on June 8, 1893. This consists in furnishing to papers in the State the short reading articles concerning the Station, arranged in plate-matter, three columns monthly. This plan has also proven valuable like the former one, and in addition the articles are ensured a circulation many times more than could have been the case before.

Such have been the calls for information contained in these Press Service Bulletins, that it has been determined to reprint, in the following bulletin, the seven monthly instalments published from June to December, 1893, inclusive. Such also have been the repeated endorsements of the plan of sending out this information, that the Station does not fear adverse criticism (if there be any) questioning whether such work legitimately comes under the scope of agricultural research and experimentation. If there should be any critics disposed to doubt the advisability of it, their attention is drawn to the *first* sentence of the well-known Hatch Act.

"That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment," &c.

H. B. Battle, *Director.*

THE EXPERIMENT STATION

Of North Carolina at Raleigh.—Important to Farmers.

JUNE 8, 1893.

This institution was organized by legislative enactment in 1877, and has for sixteen years been laboring for the best interests of the agriculture of North Carolina.

The station has issued during these years a million and more copies of bulletins, all bearing upon improvement of the state's agriculture. By disseminating this information, and through the Fertilizer Control, the station has saved millions of dollars to the farmers of North Carolina.

The fund for the support of the station is derived from the general government, and no appropriation is received by it from the state.

The station desires and needs the active co-operation of all people of the state, for without this co-operation it can do but little effectual and permanent work.

In order to extend its usesulness, the station will present to the readers of this paper, once each month, three columns of matter of peculiar interest to farmers.

The general subjects embraced in this agricultural matter will be

1. Announcements.
2. Descriptive notes of Station bulletins.
3. Summaries of results of investigations at the Station.
4. Letters of inquiry and replies to same
5. Special agricultural articles of general interest.

Letters of inquiry from any person upon any agricultural subject will be encouraged. Replies to same will be made at once by the member of the Station staff most competent to do so, in whose special field the question lies. All questions must invariably be addressed to "The N. C. Agricultural Experiment Station, Raleigh, N. C." Questions and replies of general interest will be also printed in these columns for the benefit of all readers.

The bulletins of the Experiment Station are supplied free to those residents of the State who request them. The regular bulletins contain such subjects of immediate interest and value, and are written in plain language for popular reading. Technical bulletins are issued also, and contain result of scientific and technical investigations. A list of bulletins already issued which can now be supplied will be printed in these Experiment Station columns for July.

Organization of the Experiment Station.

As at present constituted, the staff of the Station includes:

H. B. BATTLE, PH. D., Director and State Chemist.
F. E. EMERY. B. S., Agriculturist.
GERALD MCCARTHY, B. Sc., Botanist and Entomologist.
W. F. MASSEY, C. E., Horticulturist.
C. F. VON HERRMANN, Meteorologist.
B. W. KILGORE. M. S., Assistant Chemist.
F. B. CARPENTER, B. S., Assistant Chemist.
R. E. NOBLE, M. Sc., Assistant Chemist.
ALEXANDER RHODES, Assistant Horticulturist.
ROSCOE NUNN, Assistant Meteorologist.
A. F. BOWEN, Secretary.

The Experiment Station has two general parts, as follows:

A.—The Fertilizer Control Station.
B.—The Agricultural Experiment Station.

In order to facilitate its work, the Station has been classified into

1. Executive Division.
2. Chemical Division.
3. Agricultural Division.
4. Botanical Division.
5. Entomological Division.
6. Horticultural Division.
7. Meteorological Division.
8. Division of Publication.

Visitors are cordially welcomed at any time, and the work carefully explained to them. The headquarters of the Station are in the Agricultural Building, immediately north of the Capitol building in Raleigh. In the north wing are located the offices, the chemical laboratories and store-rooms. On the basement floor is the document room, where are kept the publications of the Station, and where the mailing of these publications takes place. On the third floor is situated the mycological laboratory, botanical and entomological work-rooms; also the meteorological division of the Station, organized as the State Weather Service, co-operating with the United States Weather Bureau. On the roof of the building are located the various instruments for recording meteorological observations, together with a thirty-five foot flag-staff for displaying flags for disseminating the weather forecasts.

The Experiment Farm is located about one mile and a half west of the city, and adjoins the grounds of the State Agricultural Society. It is in close proximity to the grounds of the North Carolina College of Agriculture and Mechanic Arts, and the students have access to the experiments, and

study their progress and their results. On the farm are located the experimental dairy, silos and barn, in which are the cattle under test for production of beef, milk and other purposes. Field-crop tests are also conducted, as far as is possible, upon the land of the farm. Here, also, is the field and plant house work of the horticultural division. The Experiment Farm is connected by telephone with the city offices. The Hillsboro street line of electric cars of the city stops in easy walking distance of the farm.

Silage Corn and Silo.

(F. E EMERY, AGRICULTURIST, EXPERIMENT STATION.)

Plant your corn just as you would to make a crop of grain. Cut it up and put in the silo when the kernels are well glazed, that is, while the stalks and most of the leaves are still green, and the kernels are beginning to harden. You can count 40 to 50 pounds per day for a mature animal, cow or mule, which would be 9,000 pounds per animal from Nov. 1st to May 1st. Four animals would eat 36,000 pounds. There will necessarily be some waste, and you may want to feed another cow, so we will raise this amount to 25 tons. At 25 pounds per cubic foot, this will require 2,000 cubic feet. Ten feet square and 20 feet high will be a good form. Perhaps you can get out the timber needed for the walls and roof, and need to buy only the boards, sheathing, nails, doors and hinges, and a window for the gable opposite the door.

If you have a sidehill convenient to your stable, you can put your silo into it so as to fill from above to good advantage. Make a firm base with a good foundation. I would use some cement to make a tight bottom (in a dry place well rammed clay will do as well) and lay the sills, which may be of 2in. x 10in. plank doubled and spiked together, in fresh cement.

A bill of lumber sufficient to build such a silo would be as follows:

Sills, 8 pieces,	12ft. x 2in. x 10in.	160 sq. ft.
Studs, 24 "	20" " 2" " 8 "	640 " "
" 4 "	20" " 4" " 8 "	214 " "
Plates, 4 "	12" " 1" " 6 "	24 " "
Rafters, 14"	10" " 2" " 4 "	94 " "
Common boards 12ft. long, inside cover,		960 " "
Matched pine,	" "	1100 " "
Roof of common boards, 14ft. long,		250 " "
Outside cover of wall, common boards, 12½ft. long,		1000 " "
Outside cover for water-table to cover sill,		26 " "
Total,		4,468 " "

The door hinges and nails with hasps, together with two barrels of cement and two of lime, for foundation and floor, will be all the additional expense for material.

Station bulletin No. 80 treats of silos. It is sent upon application.

Insects Beneficial to Truck and Other Crops.

(GERALD M'CARTHY, ENTOMOLOGIST, EXPERIMENT STATION.)

Insects are not altogether useless or noxious. The value of the silk worm and honey bee are known to all. Insects play a most important part in the fertilization of the ovules of many species of plants. There is a large class of rapacious and carnivorous insects which are in an indirect way, extremely useful to all growers of plants, because they hunt out and destroy the eggs, larva or mature forms of noxious insects.

Cuts show exact size except where lines indicate natural length.

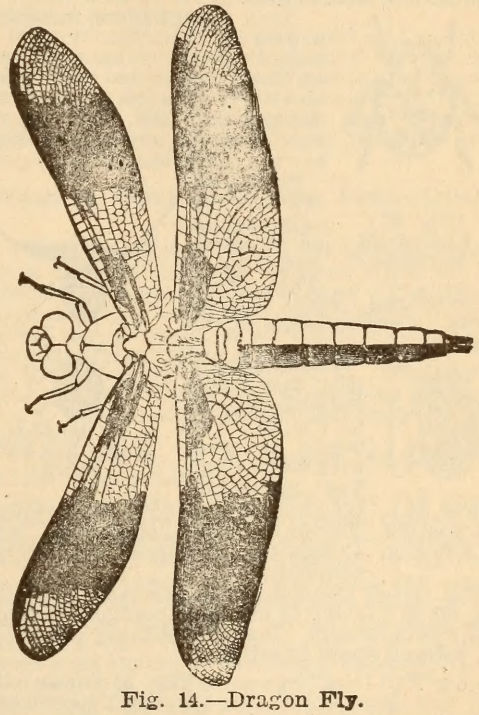
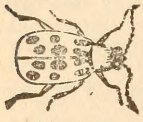


Fig. 14.—Dragon Fly.

While waging a relentless warfare upon the insects which prey upon our crops, we should spare, encourage and protect our insect allies. These latter, as one might imagine from their predacious habits, are generally large and ferocious-looking, with powerful jaws for seizing and tearing their prey. In spraying with insecticides no discrimination can be made between friendly and injurious insects, but as the friendly insects are carnivorous and do not eat the foliage, they are not hurt by Paris green or London purple. They are, however, killed by the kerosene emulsion and all insecticides which kill by touch. Many farmers who have to resort to hand-picking to save their crops, finding these ferocious looking, carnivorous insects more or less abundant upon the plants, conclude that these must be the parent forms of the lice or worms which do the damage. These, then, are carefully picked off and destroyed, in the belief that in this way the increase of the noxious insects may be prevented. This is a very unwise proceeding. These ferocious-looking, predacious insects are among the farmer's best friends. Where they are present in considerable numbers the further increase, if not the reduction, of the noxious insects is assured, with no cost to the farmer.

Among predacious insects none are more beneficial than the "lady-bugs," (Coccinella)—several species. These are the natural enemies of plant-lice. The larva of the lady-bug resembles a miniature alligator, and its appetite for plant lice is simply amazing. The lady-bugs vary in color and size, but they are all small, and the usual colors are red or pink spotted with black, black spotted with red, and yellow spotted with black.

The noxious cucumber beetle may be known from the true lady bug by its being striped instead of spotted. Lady bugs with us are never striped.



(Fig. 9)

The squash-borer. (Diabrotica 12-punctata, Fig. 9) also a destructive insect to crops resembles a lady bug, but it is larger and has long "feelers," which lady bugs have not. The Diabrotica is greenish-yellow, with black spots.

squash-borer. There is another insect closely related to the true lady bugs (Coccinella and Hippodamia) which feeds upon cucumber and squash plants.



(Fig. 22.) Epilachna Borealis.

This is Epilachna borealis, shown in Fig. 22. It is of a reddish-yellow color, with seven black spots on each wing cover. It is much larger than the true lady bug. Among our most common and useful allies are the following:

The 9-spotted lady bug, (Coccinella novempunctata, Fig. 23) This beetle is brick-red, with 9 black spots. Very common in this state.





(Fig. 23.) Lady bug and larva.



(Fig. 24.) 10-Spotted Lady-bug.

The 10-spotted lady bug, (Hippotamia maculata, Fig. 24.) This beetle is pink, with black spots. The convergent lady bug, Hippodamia convergens, Fig. 25.) This is orange-red, with 13 small black spots. Also rather common.

The Green Ground-beetle, (Calosoma scrutator, fig. 27.) is one of our most common, elegant and useful insects. It is of a shining green color, without spots or stripes.

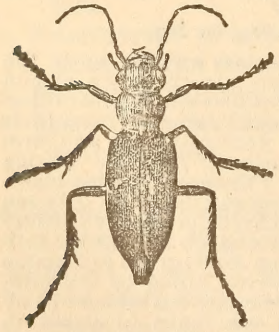


Fig. 10.—The Virginia Tiger-Beetle.

Fig. 10 shows the Virginia Tiger-Beetle (Tetracha Virginica) It is of a shining green color, with brown legs, of the exact size shown.

Fig. 11 shows the Elongated Ground-Beetle, (Pasimachus elongatus.) It is of a shining black color, with dark-blue edge.

Fig. 12 shows the Banded Soldier-Bug, (Milyas cincinatus.) The line at the left shows exact size.

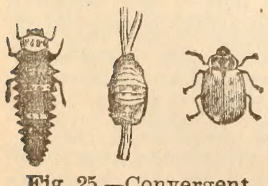


Fig. 25.—Convergent Lady-bug. a. larva. b. pupa. c. Adult.

The Fiery Ground Beetle, (Calosoma callidum, Fig. 26) is one of our largest, most beautiful, ferocious and rapacious insects. It feeds chiefly upon cut-worms, but destroys vast numbers of cotton and boll-worms. This beetle is shining, greenish-black, with golden dots in straight rows. It is most useful in the larva state.

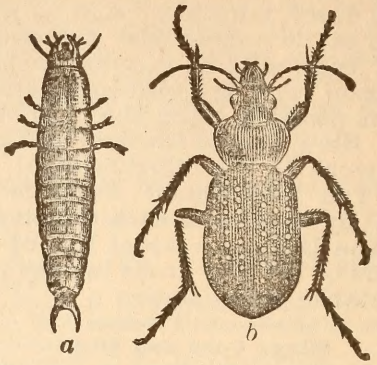


Fig. 26.—The Fiery Ground-Beetle and Larva.

This is one of our most elegant insects. The colors are black, white and yellow. It lives chiefly on trees, feeding upon worms and bugs it finds there.

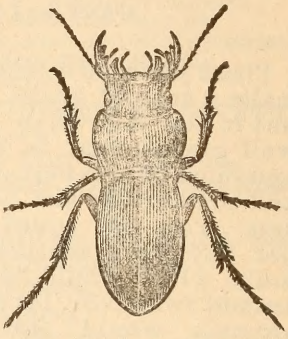


Fig. 11.—Long Ground-Beetle.

Fig. 13 shows Thick Thighed Soldier-bug, (Acanthocephala femorata.) This insect is very common in the South. It is of a black-brown color, sometimes inclining to red. It is of the exact size shown.

Fig. 14 shows the Dragon-Fly, or "Devil's Darning-Needle," (Libellula trimaculata.) It is our swiftest flying insect. In the larva state it feeds upon mosquitoes; in the adult

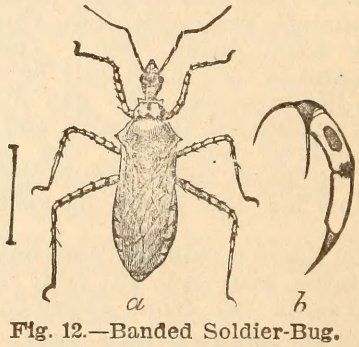


Fig. 12.—Banded Soldier-Bug.

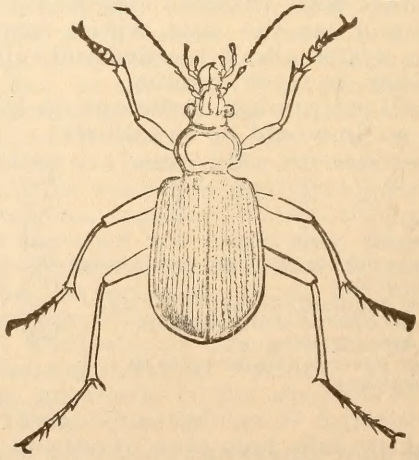


Fig. 27.—Green Ground-Beetle.

state it feeds upon many insects. It never harms human beings or animals. It should not be persecuted.

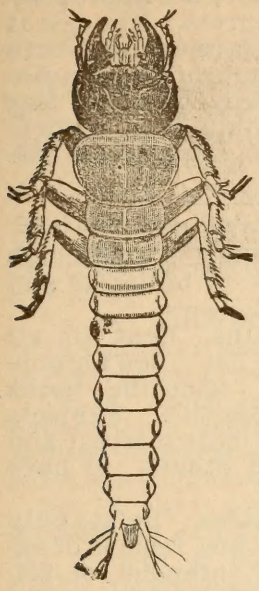


Fig. 29.—Larva of Murky Ground-Beetle.



Fig. 28.—The Murky Ground-Beetle.

Figs. 28 and 29 show the Murky Ground-Beethe, (Harpalus caliginosus) and its larva. The beetle is of a blackish color, of the exact size shown.

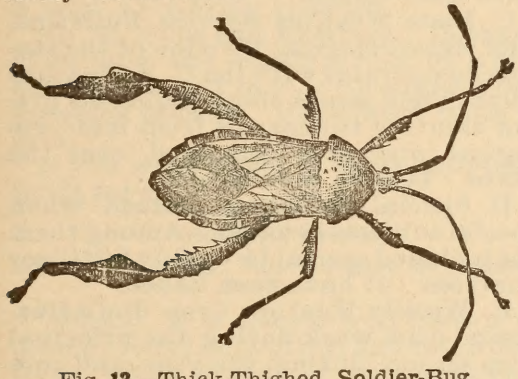


Fig. 13.—Thick-Thighed Soldier-Bug.

Questions and Replies.

Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Questions may be sent in by any one and the subjects may embrace any agricultural topic. Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render great assistance to practical farmers.

Wicky Laurel, or Lambkill.

I send a box of leaves to learn if they contain any poison. I have lost two fine horses, supposed to have been poisoned.—E. F. A., Laurel, N. C.

Answered by Gerald McCarthy, Botanist Experiment Station.)

The leaves sent are those of Kalmia angustifolia, popularly called Wicky Laurel and Lambkill. This plant is considered poisonous to sheep, but has never been known to kill horses or other animals. Yet it might do so when the animals gorge themselves upon the leaves, as they are liable to do when turned out too early, before the grass starts in the spring, and when there is nothing else for them to eat. This shrub should be carefully eradicated from pasture lots.

Vinegar Eels.

I send you a small bottle of vinegar which has worms in it. Please let me know if these are always present in vinegar, or if they are unwholesome.—J. S. D., Creek, N. C.

(Answered by Gerald McCarthy, Botanist Experiment Station.)

The sample of vinegar contains "vinegar eels" (Vibrones aceti.) Their presence is caused by too much exposure of vinegar to the air, and probably by bad or unskillful handling of the fruit from which the vinegar was made. Heat the vinegar until it is scalding hot—about 160 degrees, F.—at which temperature keep it for half an hour, then strain through cotton sheeting, barrel and bung it tightly. Do not boil the vinegar, as that will injure the quality. After being treated as indicated the vinegar will be perfectly wholesome, though not quite so strong as might be.

Mixing of Watermelons and Cantaloupes.

Is it good practice to have watermelon and cantaloupe patches along side of each other? Will either corrupt the other?—R. B. C., Charlotte, N. C.

(Answered by W. F. Massey, Horticulturist of Experiment Station.)

It was formerly supposed that all cucusbitaceous plants would mix if planted close to each other, but investigations of late years show that there is really very little crossing, even of those near akin. The muskmelon and the watermelon will not cross at all, and you may plant them together freely.

When to Plant Black-eye Peas.—Cultivation of Sage.

I have just picked from a five acre field truck peas, and am desirous to know when, or how soon I may plant black-eye peas. The farmers here say wait until the dark nights in June. What has the moon to do with it? I am thinking about planting an acre or so in Sage, that is, if there is any market for it. What is the best variety to plant, and when is the best time, etc.? What does it usually sell for?—E. E. E., Coleraine, N. C.

(Answered by W. F. Massey, Horticulturist Experiment Station.)

Plant the peas at once, now that the ground is warm. There are still a great many people who study the moon more than the condition of their soil. If the land and season is all right, and the proper cultivation given the crop, it will be good. Sun and rain have far more to do with it than the moon. Broad leaf sage is the kind to grow. It is now rather late to begin. Sage seed should be sown early in April in a rich bed, and the plants transplanted to a piece of land from which an early truck crop has been cut. The plants set in rows 2½ feet apart and 12 inches in the row, will, if land is good, nearly cover the ground by September, and as all the growth is young and tender it can be cut off at the ground and cured in the shade. If properly cured it will sell better in any of the northern cities, Baltimore especially.

Best Varieties of Early Corn and Turnips.

I want to plant for market, North, corn for early roast-ears, and also a crop of early turnips. Will you not please write me as soon as you can what variety of corn will pay best to plant for early market, and what variety of turnips planted this season of the year will do best?—J. L. K., Tarboro, N. C.

(Answered by W. F. Massey, Horticulturist Experiment Station.]

The best corn you can plant for early shipping is Adams Extra Early. There is a variety of this grown by the market gardeners in Patapsco Neck, near Baltimore, Md., known there as the Neck corn, which is larger, earlier and better suited to our climate than the northern Adams. You can get it, I think, from J. G. Bolgiam & Son, Baltimore. For a crop of early turnips use the Extra Early Milan. It grows almost as quickly as a radish and is much earlier than the ordinary flat Dutch turnip.

THE N. C. AGRICULTURAL EXPERIMENT STATION.

OF INTEREST TO FARMERS.

July 8, 1893.

What is An Agricultural Experiment Station?

It is an institution established to benefit agricultural industry.

How can it do this?

To bear the expense and to conduct work which will be useful to enterprising farmers. Many of these often desire to investigate for themselves but are prevented by expense and lack of facilities. At an experiment station are employed scientific and practical men who, with every facility, devote their time in investigating agricultural subjects.

What are these subjects?

How can farming be made to pay? How can we improve our worn soils at a minimum expense? How should certain soils be fertilized to yield the best crop? How can waste products be saved and utilized? Can new plants be advantageously grown? The value of certain foods for cattle. The best grasses for centain soils. The dairy industry. The value of ensilage. A study of the diseases and insects affecting crops, and the best methods to prevent their ravages. To determine the best varieties of grasses, fruits, and vegetables for the highest markets. These and a score of kindred subjects.

How long will it take to reach these conclusions?

Answers should not be expected in a short time. In many cases several seasons of careful work will be necessary. In the meantime the Station seeks to disseminate valuable facts and truths which will enable farmers to make and save money.

Is the North Carolina Station at Raleigh doing all this?

Yes; and in addition, through the Fertilizer Control, it protects farmers from fraud in the sale of fertilizers. In this way it has already saved them millions of dollars. In answering correspondents, it is always ready to give the best advice it can on agricultural subjects.

Does the Station print the result of its work?

Yes. It issues frequent bulletins, and reports. These are all free to those who request them. By valuable co-operation of the press of the State, notes of the work of the Station are printed in their columns from time to time.

How is the North Carolina Station at Raleigh supported?

Funds for its support are appropriated by the U. S. Congress. Though it is working for the farmers of North Carolina, the state appropriates nothing to it. No one need, therefore, fear that the cost to sustain it is burdensome. [H. B. BATTLE, Experiment Station, Raleigh.]

Publications of the Experiment Station.

The Experiment Station at Raleigh publishes six classes of bulletins and three of reports, as follows:

A. Regular Bulletins. Sent to all names on the station list. Are for popular reading, with scientific terms avoided as far as possible. Subjects are chosen to be of most interest and value to farmers and others. 91 have been issued.

B. Technical Bulletins. Relate only to technical subjects and results of experiments, and only intended for scientific and technical exchanges. 6 have been issued.

C. State Weather Service Bulletins. The Meteorological Division of the station co-operates with the U. S. Weather Bureau and issues these bulletins giving monthly summaries from meteorological observers scattered over the State. 44 have been issued.

D. Special Bulletins. Issued when special subjects demand. Among them are included special bi-weekly fertilizer analyses. 15 have been issued.

E. Weekly Weather Crop Bulletins. Issued each week during the principal crop season during the year, and contain compilation of reports from several hundred observers in 90 of the 96 counties of the state. Copies are sent to any one who desires, provided he posts them in a conspicuous place after reading. 132 have been issued.

F. Press Bulletins. Contain short reading articles for newspaper columns about the station and its work. 44 have been issued.

G. Annual reports of the station. These give outlines of work done, and not details, during the year. 15 have been issued.

H. Annual Reports of the State Weather Service. Contain summary of work during the year, and valuable meteorological facts are recorded. 6 have been issued.

I. Biennial Reports of the Station. Sent to the governor for transmission to the legislature every two years. Give outline of work accomplished during this period. 7 have been issued.

PUBLICATIONS ARE FREE.

The bulletins and other publications of the Experiment Station are free to

any one in North Carolina who requests them. Write application to

DR. H. B. BATTLE, Director,
Raleigh, N. C.

SOME INTERESTING BULLETINS.

No. 70. The Weed Pests of the Farm, and How to Exterminate Them. 32 pages with 10 full-page cuts.

No. 73. The Best Agricultural Grasses. A valuable compendium of 100 pages, with 74 cuts, many of full pages. Seed and seed adulteration is also treated. Mixtures for sowing on different soils are given.

No. 77. Value of Pea Vine Manuring; with full-page photographic cut showing increased growth of wheat. 8 pp.

No. 78. Some Injurious Insects. 32 pages giving descriptions of injurious insects, illustrated with 38 cuts. Remedies are suggested also.

No. 79. Facts for Farmers. 24 pages devoted to explaining in a plain way the growth of plants and what they need. Home-made manures are also treated, and the action and use of lime. A very interesting bulletin.

No. 80. Silos and Ensilage. 18 pages describing the construction of a silo and what to put in it, with suggestions for stock rations. Illustrated with 12 cuts.

If you want either of these bulletins, write for it.

Gapes of Fowls.

(Gerald McCarthy, Entomologist Experiment Station.)

"Gapes" is a disease well known to most growers of poultry, and often destroys whole broods of young chicks. The disease is caused by a very slender, thread-like, reddish nematoid worm, scientifically known as syngamus trachealis. This worm is characterized by the permanent union of the paired sexes, and cannot be parted without rupturing the bodies. The female greatly exceeds the male in size.

The matured worms are found only in the wind-pipe of fowls to which they cling leech-like on the walls, sucking the blood of the parts. The female of each pair produces 2,000 to 3,000 eggs which remain within her body until she dies. They are then loosed by the decay of the parent body, and if they remain within the wind-pipe of the fowl the young worms emerge from the shell in a few days, and in a few days are mature couples and begin to reproduce eggs. The hatching of the egg occurs only when it is kept constantly moist and at a temperature of about 68 degrees F. The sexes never pair except in the wind-pipe of a fowl. If the temperature is below 60 degrees F. the eggs will not hatch, but will retain their vitality for a year or more, provided they are kept moist, hence contagious gapes is a wet land disease. When the affected fowl gapes and coughs for breath some of the worms with their eggs are ejected into the water troughs where the fowls frequently congregate, evidently trying to allay the inflammation in the wind-pipe by drinking copiously. The ejected worms or eggs are greedily eaten by other fowls present, or the water containing them is drunk, thus spreading the disease, and in large flocks producing a veritable epidemic.

REMEDIES.—The best remedy is prevention. Keep the fowls on dry permeable soil. Feed generously, including chopped onions or garlic occasionally. Wash out the water trough or pan daily with boiling water. If gapes is present among the fowls, separate the sick ones, add to each quart of drinking water four fluid ounces of a solution of salicylic acid, made by dissolving 16 grains of the dry acid in four fluid ounces of clear, boiled rain water. The pen in which the sick fowls are kept should be as dry as possible, and the ground should be sprinkled twice daily with water, to each quart of which add four fluid ounces of commercial sulphuric acid.

Where only a few fowls are affected a bit of camphor about the size of a grain of wheat may be forced down the throat of each and will by its odor kill the worms. One drop of turpentine dropped into the throat has given good results. Powdered asafœtida, 10 grains per head, may be fed in a mash of corn meal. Chopped garlic or strong smelling onions will also be found beneficial. Turpentine rubbed on the outside of the throat will sometimes cause the worms to let go their hold. The use of a small feather or hair loop, dipped in turpentine and thrust down the wind-pipe of the sick fowl is often effective. The worms may either be withdrawn or else coughed out by the chick.

The Oxford Tornado of May 3d, 1893.

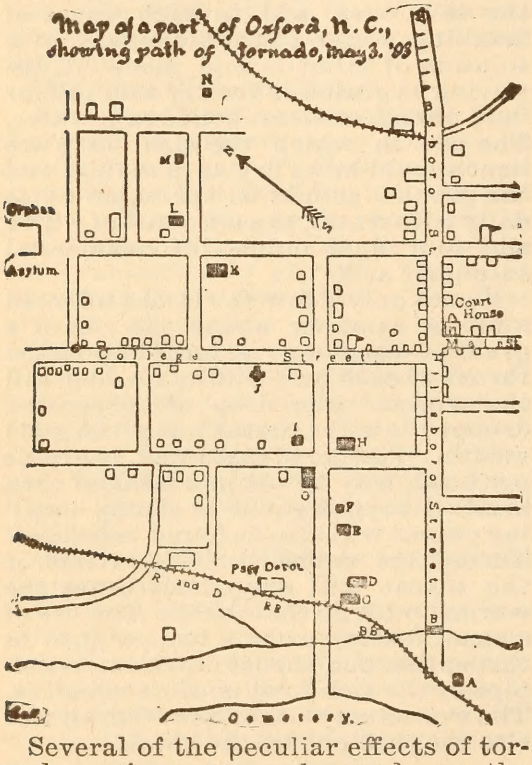
(C. F. vonHerrmann, Meteorologist Experiment Station.)

The tornado which occurred at Oxford on May 3d, 1893, was the most severe storm of the kind which has occurred in North Carolina since 1884. On that account it was investigated by the State Weather Service. Full reports have been received from Mr. Z. W. Lyon, Dr. J. E. Wyche, R. O. Gregory, and an excellent map, reproduced below, showing the path of the tornado, from Dr. J. M. Hays.

The storm struck Oxford at 3 minutes before 5 o'clock p. m. It was a local whirl within the area of a general storm passing over the state from south

to north, and occurred just at the moment the "critical line" or trough of low pressure passed Oxford. It is remarkable that there was an entire absence of any close or murky feeling such as is usually said to precede a tornado. The day was cool, the temperature was about 70 degrees; a moderate thunderstorm prevailed with brisk south to southwest winds. The total rainfall was about 2 inches.

The path of the tornado was from southwest to northeast through the city, and its width about 75 feet. The buildings demolished or injured are indicated on the chart by the letters A to N. Four houses were destroyed and nine others injured. A fair estimate of the damage to property places the amount at $16,000. Only one person (a negro boy) was killed.



Several of the peculiar effects of tornado action were observed, as the blowing out of the ends of buildings by the expansion of the air within, the whirling of heavy articles from the south to the north side of the storm, etc. Quantities of shingles and timbers were lifted up and scattered about. Its chief effect seems to have been a crushing action, and its force is indicated by the destruction of Burwell's prize house (G), a three-story structure of brick strongly built.

It was very dark at the time of the storm, so that persons within a few hundred feet of its track were not aware of what was occurring. There is no evidence that any one saw a funnel-shaped cloud.

Commercial Bulb Culture in North Carolina

(W. F. Massey, Horticulturist, Experiment Station.)

The ease with which flowering bulbs of all sorts are grown in North Carolina satisfied me long ago that a profitable industry could be built up here in this line. Few people who are not familiar with the flower trade realize the vast sums spent annually for bulbs of Hyacinths, Tulips, Narcissus, Lilies and the like. Hundreds of thousands of dollars are annually sent abroad to Europe for these bulbs, all of which can be as well, or better, grown in North Carolina.

Mr. C. L. Allen, a leading New York florist, seeing the superior quality of Lily and Hyacinth bulbs sent from North Carolina, wrote an article in the American Agriculturist a year or so ago, urging the commercial culture of bulbs in North Carolina. The writer of this has since tried to second Mr. Allen in attracting attention to the capacity of the State in this respect, and it is likely that ere long men of experience and means will start this business here. In the Eastern part of the State the culture of Tuberose bulbs has for years been a matter of some importance, and the markets of New York and London are mainly supplied with North Carolina Tuberose bulbs. But the tuberose has lost its popularity with fashionable people and the demand for the bulbs has decreased. But there are many other bulbs that are used in increasing quantities annually that can be grown here as well as Tuberoses. The best Lily soils in the State are the black peaty lands of the immediate coast. These are also the best Hyacinth lands. Narcissus, Roman Hyacinths, and Gladiolus are better for the upland districts. The Gladiolus particularly is more adapted to the upland soils. Mr. Allen thinks that the Piedmont section is best for all bulbs and I have no doubt that good bulbs can be grown all over the State. But an experience in handling and cultivating these bulbs for over thirty years makes me feel certain that for Lilies and Dutch Hyacinths, at least, the black soils of the coast region are far superior to any other in the State. They are in fact the same character of soil as that of Holland in a climate incomparably superior to that of Holland. If this culture is once started in North Carolina by men of experience there is no doubt that a good and profitable industry will be added to the State. Attention is being attracted to the State by articles written by Mr. Allen and myself, and lately a large Dutch grower of bulbs at Haarlem in Holland,

wrote to Mr. Allen for further information, saying that he is thinking of transferring his business to this country. In speaking of soil needed, this gentleman says of Hyacinths, "they are planted in different grounds; one year in a sandy one, another in a black humus ground. Therefore it is of great interest to choose a country where different grounds are to be found. Also that the ground must be situated so that it will not suffer from drought, nor where the bulbs will be drowned out." These conditions are easily found in the coast country of North Carolina. We are strongly in hopes that this gentleman may be induced to come here and start this business, which has been the source of so much wealth to Holland and for which our soils and climate are far superior.

Since writing the foregoing Mr. C. L. Allen writes that a year or so ago he imported 100,000 Lily bulbs from France, which came in such bad order that they were unfit to sell. He sent them to the neighborhood of Southern Pines and grew them there one season. The result, he states, was astounding. After one season's growth in North Carolina they were better bulbs than any imported from Europe. He adds, "There is plenty of land in your State selling for less than $10.00 per acre that is just as good for the production of bulbs as the land in Holland that is worth $3,000 per acre. This is no idle dream; having been frequently in Holland to buy bulbs, I know their methods perfectly, as well as the soil and climate and know the bulbs can be produced here at much less price than there."

Questions and Replies.

The Station will be glad to receive any question on agricultural topics any one may desire to send. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render great assistance to practical farmers.

The Culture and Fertilizing of Potatoes.

I want special information on the culture and fertilizing of the potato. I do not have as much stable manure as I need; will have to buy some commercial fertilizer. What to buy for economy? How much to use for the greatest profit? I have good potatoes made from Northern seed; some from seed raised in the country; former much better. Will it pay to sell what I have and buy Northern seed? Have tried an experiment with the different ends of potatoes. I am not satisfied yet. The little end seemed to produce fourteen pecks where the large end, or vine end, gave only nine, but the little end did not give as smooth and nice potato as the large end. I used a little phosphate, found it to pay best where I put most. I used at the rate of 300 to 400 pounds to the acre.—T. H. E., Nebo, N. C.

(Answered by W. F. Massey, Horticulturist Experiment Station.)

The lack of stable manure need be no hindrance to the growing of good crops of potatoes. In fact, I have long ago abandoned the use of stable manure for this crop, as it seems to promote the growth of scab fungus. The best preparation for a crop of Irish potatoes is a good clover sod or pea fallow plowed late in Fall so as to get well decayed by planting time. Next best a piece of newly cleared land. Use a complete fertilizer analyzing about 7 to 8 per cent Phosphoric Acid, 4 to 5 per cent Nitrogen (as Ammonia) and not less than 8 per cent Potash. If on a clover sod, less Ammonia will do, but we find that the crop needs more Nitrogen South than it does at the North. Use this at the rate of 600 to 1,000 pounds per acre for first-class results. Our Newbern truckers rarely use less than 1,000 pounds. Cut good sized potateos into good sized pieces and plant as early as you can work the ground in good order in February or March for the early crop. The best seed to use we have found to be potatoes of the late Fall crop grown here. They will always do better than any Northern seed, of same variety. You have grown seed probably not of the late Fall crop and had been kept too long for good results. If you would send into the Eastern truck section and buy the second crop seed you would find them better than Northern. In your elevated mountain country it may not be practicable to raise a second crop from your early ones, but if you could get some of the late Fall crop potatoes from the Eastern part of the state in early Spring and keep them until July 1st or late June, and plant them, you could use a better keeping crop for winter use, and for planting the following Spring.

Grape Vine Lice.—Apple Trees Dying.

Enclosed find specimens of insects that infest my grape vines more or less each year. They do no serious damage. Would like to know what they are and how to destroy them.

What causes so many apple trees to die in the twigs about May 1st?—S. A. A., Pleasant Lodge, N. C.

(Answered by Gerald McCarthy, Botanist Experiment Station.)

The insects are Siphonophora viticola, the grape vine louse. This is not the much dreaded phylloxera, but a closely related species. This insect may be readily destroyed by spraying with the kerosene emulsion, or tobacco decoction prepared according to formulas Nos. 8 and 10, bulletin No. 84, of this Station. The insects, if let alone, will disappear of themselves shortly, as they are pursued by numerous enemies among their own kind.

The dying of apple twigs is probably caused by the Fire Blight, a bacterial disease for which there is no remedy except excision and burning, which should be promptly attended to. Always cut off the diseased twig at least six inches below the lowest discolored point. Burn the part cut off.

Blue Stone for Corn.

Please write me if, in your opinion, it is best to soak corn in blue stone before planting it.—J. P. B., Germanton, N. C.

(Answered by Gerald McCarthy, Botanist Experiment Station.) Seed corn should not be soaked in blue stone as the treatment will injure the sprouting power of the grain and so cause an uneven stand. The only purpose which such a treatment could serve would be the destruction of the spores of corn smut, (Ustilago maydis.) But the spores of this fungus are more likely to be present in the soil, or manure put on it, than on the grains of sound seed corn. The best preventive of corn smut is rotation of crops, and the removal and destruction by fire of all smutty ears as soon as they show upon the growing plants.

WITH THE FARMERS.

THE N. C. AGRICULTURAL EXPERIMENT STATION AT RALEIGH

Presents Matters of Interest to the Tillers of the Soil—Questions Answered and Timely Advice Given.

AUGUST 12, 1893.

Cultivation and Soil Moisture.

Very numerous experiments have been recorded to show that moisture is saved by cultivation. During hot, dry weather every foot of plowed land should be kept well stirred on the surface with any tool which tends to keep it from baking. A loose, fine surface will hold down water like a wet blanket. A field kept thus may give an increase in crop over one not cultivated equal to that produced by a heavy application of fertilizers. Preservation of the soil water thus becomes of great importance. A blanket of fine soil on the surface during a hot, dry week can be of great value to the crop and really become the turning point for profit if present when loss might result from its absence.—Frank E. Emery, N. C. Experiment Station.

The Late Crop of Irish Potatoes in the South

The above is the title of an interesting bulletin, No. 85, of the N. C. Agricultural Experiment Station, by Prof. W. F. Massey, Horticulturist of the Station. The subject is an important one and the industry based upon it is destined to become a most valuable one to the South. Of the many thousands of barrels of seed potatoes now annually brought from the North both for seed and food, a few years hence will be reduced to as many hundred. The truckers in the East Atlantic States, to a large extent, now plant home.grown potatoes for the second crop, and it will not be long before the practice will become universal. These potatoes are destined also to supply the food market to the exclusion of Northern grown potatoes.

The important points to observe in planting are: Bed the seed in the soil until planting time, about the second week in August and use only sprouted potatoes. The cut potatoes when bedded sprout better than whole ones. Plant in a deep furrow, but cover very lightly and pack the soil to the seed. Gradually fill in the soil to the plants as they grow, and cultivate the crop perfectly flat.

Suggestions as to keeping the late crop will be found in the above bulletin, as well as experiences of many truckers with this new crop.

Beware of Frauds.

It is surprising how people will be swindled by some worthless or inexpensive compound concealed under the guise of some glittering name, and selling for an exorbitant price, which does not even bear the name of the manufacturer.

Compound extract of salyx is the deceptive and ensnaring name of a compound which is being extensively sold to the people of the State to be used for preserving eggs, fruits, vegetables, etc. A package received at the Experiment Station for examination was labelled as follows:

"Two Ounce Package
Compound Extract of Salyx.
Prepared expressly for preserving Eggs, Fruits, and Vegetables, by the "Cold Process" according to Hood's formula.
Price $1.25."

This material consists of a fine, white and crystalline powder, possessing little or no odor, and the aqueous solution has rather an agreeable sweetish taste. An analysis of this powder shows it to be nothing but commercial Salicylic acid. Salicylic acid is a powerful antiseptic, and owing to its slight taste, it has been much used for preserving commercial articles of food. When taken into the system in medicinal doses it has a powerful effect upon the system, and it is believed that its continued use in food, even in small amounts, must produce none other than injurious effects. The sentiment has been so strong against its use in France and other countries that laws have been enacted prohibiting its use for preserving foods.

The so-called "Compound Extract of Salyx", besides being a very undesirable substance to mix with foods, is sold at an exorbitant price compared with actual market value.—[F. B. Carpenter, N. C. Experiment Station.

Blight and Root Rot of Cotton.

The Botanist of the N. C. Experiment Station is desirous of securing specimens of cotton showing characteristic symptoms of blight or black disease of boll and root rot. Farmers whose cotton may suffer from either of these diseases will confer a favor by sending samples and full particulars to the Station at Raleigh. Wrap samples in moistened paper, and enclose in pasteboard box. Mail to North Carolina Experiment Station, Raleigh, N. C.

Warehouse and Flour-Mill Pests.

(By Gerald McCarthy, Entomologist, Experiment Station.)

One of the most dangerous insects which infest flour mills is the so-called Mediterranean Flour Moth (Ephestia Kuhniella). This insect is known to exist in North Carolina, and is likely to become a most serious and expensive

pest. Figure 1 shows the appearance of this insect in different stages of growth.

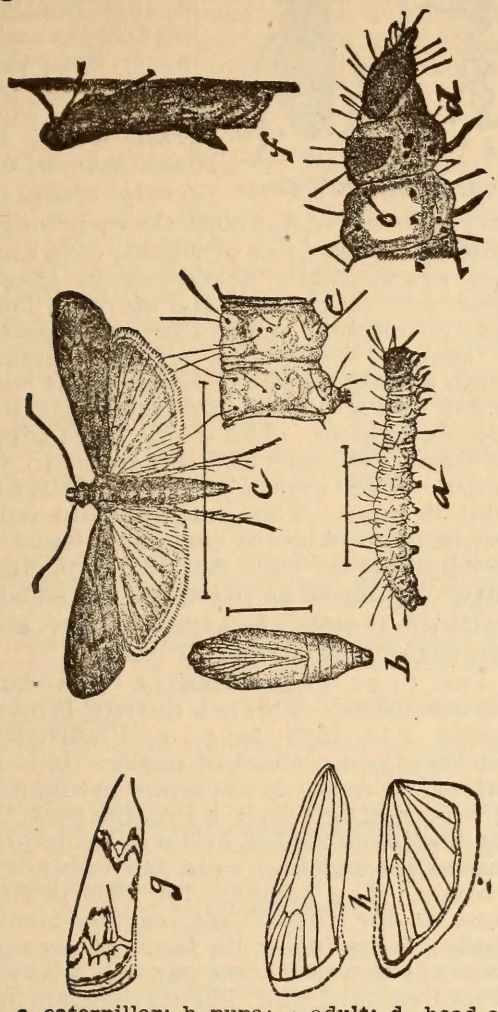


FIG. 1.—MEDITERRANEAN FLOUR MOTH.

a, caterpillar; b, pupa; c, adult; d, head and fore-part of caterpilla; e, hind-part of caterpillar; f, adult moth seen from side; g, h, i, views of wings. The lines show exact size.

This insect is of obscure nativity, but is thought to be American by European entomologists. It first became troublesome on this continent in Canada in 1889. In the province of Ontario it infested several large flouring and patent food mills to such an extent as to compel the stoppage of the works for several weeks while all hands were put to work cleaning and fumigating the mills. The loss to several of these establishments, including stock and bolting cloths ruined, and loss of time and labor, must have exceeded $1,000 each.

The moth which produces this destructive caterpillar is a slender lead-colored insect, about 1 inch long. The wings have wavy black lines near the tip. The insect is rather sluggish and often remains in one position for a long time. This moth can probably be found active in this state in all months of the year except January. The eggs are whitish or pink, and kidney-shaped. The eggs are usually laid on outside of sacks and in the cracks of bins. They hatch in about 20 days. As soon as hatched the caterpillar makes its way into the flour and there spins around itself a silken tunnel in which it lives and feeds on the flour. These tunnels cause the flour to become knotted into clots which refuse to pass through the machinery, rendering the material worthless, besides clogging the cloths, screens and spouts.

REMEDY: The only practicable remedy for this pest is to fumigate the entire mill and building in which flour and manufactured foods are kept with carbon bisulphide.

This substance is a fluid having a most disgusting odor. It vaporizes readily when exposed to the air and in this condition is destructive to all forms of active insect life. To use it, the room or building to be fumigated must be closed as tightly as possible. All interior doors should be kept open. Expose the liquid in shallow pans or saucers and close the building for 24 to 48 hours. Then open all doors and windows and allow the gas to disperse in the air. Care should be exercised to avoid breathing the gas and on no account should any fire or light be brought into the room or building while the peculiar odor can be smelled. This substance is highly explosive and inflamable. With care no harm will follow its use. When the gas disperses in the air it leaves no residue behind, so that no trace of it can be found in the flour or food. Where only a small lot of goods or sacks are infested they may be placed in an air tight room, or bin and a dish of the liquid placed within near the top. Use about four fluid ounces of the liquid for each 25 cubic feet of space, or for grain or flour in a tight bin use 1 pound of carbon bisulphide for each ton. Carbon bisulphide can be bought of W. S. Powell & Co., Annapolis Junction, Md., and of Edward Clark, Columbus, O. Price about 20 cents per pound in 5 pound cans. In smaller quantities it can be had of any druggist.

THE COCK ROACH—Periplaneta orientalis, and other species.—The cockroach is one of the most common, disgusting and troublesame pests in all places where flour or bread is kept. There are two species about equally common in this State. The larger one is dark brown and varies from 3-4 to 1 inch in length. It runs very rapidly, and being so flat, it easily finds shelter in some crack when pursued. Figure 2 represents the common yellow roach, or "croton bug." It is much smaller than the other species.

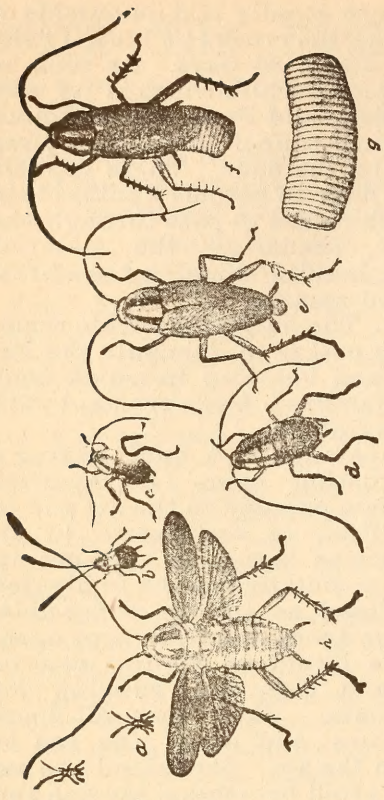


FIG. 2.—GERMAN COCKROACH OR CROTON BUG.

a, Roach just hatched: b, a little older: c, half grown: d, nearly full grown; e, adult; f, female with egg case; g, egg case enlarged; h, adult with wings spread

All roaches are enormously fecund, all voracious and eat every kind of food used by people. They prefer bread and flour, and foods made of flour. These pests are nocturnal in their habits and hence are apt to escape observation until their numbers increase so much as to render their presence alarmingly patent.

REMEDY: Cleanliness where such is practical is essential to keep free of these insects. In mills and warehouses where flour dust and grain is everywhere, the carbon bisulphide fumigation must be resorted to, and must be very thoroughly done, so that the vapor of the substance will find its way into the cracks and crevices where these pests hide. In addition pyrethrum powder should be blown into cracks where they are known to hide, or pure kerosine oil may be blown in with an ordinary oiling can. Powdered borax sprinkled on shelves where they run will drive them away. Old rags moistened with molasses water in which Paris green has been suspended will poison them. The cloths should be freshly moistened each evening and removed in the morning.

THE GRAIN AND RICE WEEVIL (Calandra)—Two Species.—In North Carolina we have two species of grain weevils, calandra granarius, which infests wheat and corn, and calandra oryzæ, which infests rice in warehouses. The first is the more common and injurious. Both species are much alike.

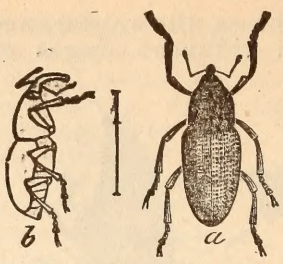


FIG. 3.—GRAIN WEEVIL.

Fig. 3 shows a back and side view of a weevil of this family, but this is much larger than the true grain or rice weevil. The grain weevil is dark brown, or nearly black, is very slender and about 1-8 inch long. Immense quantities of wheat, corn and rice are annually destroyed by these pests in warehouses and stores. The only practicable remedy for these pests is carbon bisulphide. The infected grain should be put in an air-tight box or bin and a dish of the liquid laid on top of the heap. The whole must then be tightly covered and left for 24 to 48 hours. Then expose to the air until all odor is gone. The grain or flour will not be injured by the carbon. Use 1 1-2 to 2 pounds for each ton of grain, and cover tightly so as to keep in the fumes until the insects are killed. They are exceedingly tenacious of life.

THE FLAT FLOUR BEETLE—Silvanus Surinaminsis.—This is a narrow brown beetle 1-12 inch long, and scarcely thicker than a sheet of paper. It is a native of Asia, as its name betokens. It is becoming yearly a greater pest in the Southern States, and will probably exceed in mischief even the Calandra weevils. The remedy for this is the same as for the others—carbon bisulphide. This insect is fond of greasy substances, and if some paper is soaked in melted lard and Paris green sprinkled upon it while moist and the poisoned sheets distributed on floor and shelves where grain and flour is kept, many of the beetles will be killed; but this flour will not give satisfaction where they are already abundant until the carbon has killed most of them.

As a matter of safety all mills, warehouses and stores where grain, flour, and food-stuffs are kept, should receive a thorough annual cleaning, and fumigation with carbon bisulphide. This, if attended to and thoroughly done, will save many thousands of dollars damage. It will be most efficacious if done about April 1. It may be repeated with benefit in July or August. The best time to fumigate is on Saturday evening, having thoroughly closed all outside doors and ventilators, leave them until Monday morning. The utmost care must be taken that no fire shall be taken into the building while the odor of carbon bisulphide can be smelled. Neglect of this precaution will almost certainly result in an explosion and fire. With care there is no

danger. The odor of this substance, though most disgusting, will not injure the most delicate food preparation. The odor is not poisonous to human beings unless breathed for a long time, but as little as possible should be inhaled.

QUESTIONS AND REPLIES.

The Station will be glad to receive any question on agricultural topics any one may desire to send. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render great assistance to practical farmers.

Fertilizer for Onions.

I am growing a crop of onions. Am using an ammoniated fertilizer, sixteen hundred (1,600) pounds per acre, on light sand with stiff red clay subsoil. Will that be sufficient or will I need more Ammonia and Potash? Would an application of cotton seed meal and kainit be beneficial, if so, in what proportion and how much?—B. F. S., Salisbury, N. C.

(Answered by H. B. Battle, Director Experiment Station.)

The 1,600 lbs. of the ammoniated fertilizer to the acre for the cultivation of onions is not the best that could be applied. It gives entirely too much phosphoric acid in proportion to the ammonia and potash necessary for this crop. In order to make it of better service and more nearly what has proven to be needed by onions, I would suggest the addition of

500 lbs. cotton seed meal,
800 lbs. kainit,

per acre, or if this will make the application more than you can afford, together with what you have already put on, take half the quantities. Onions require a mixture giving about

9 per cent. potash,
5 " ammonia,
5 " available phosphoric acid,

and from 1,000 to 2,000 lbs. of this mixture is the usual application. The equivalent to 1,500 lbs. of this mixture per acre could be made by mixing

800 lbs. cotton seed meal,
1,000 lbs. kainit,
600 lbs. acid phosphate.

Fertilizer to Sow With Clover For Hay.

I want to plant two or three acres in clover this Fall, and write to ask you what kind of fertilizer to use, and how much per acre. I shall have to use commercial fertilizer. Please be definite and name what brands to use. If it has to be mixed, please say just how much of each kind. Should you say use a fertilizer containing a certain per cent of one thing and a certain per cent of another, I would be as much in the dark as ever. I want the clover to cut and not to be grazed.—H. S., Monroe, N. C.

(Answered by F. E. Emery, Agriculturist, Experiment Station.)

The condition of the field should dictate how much fertilizer should be used. If poor, like some of our lands, no amount of fertilizer, but plowed-in pea vines and stable manure, top-dressed after sowing, on a thoroughly well prepared seedbed, would be required to make a fair stand and good growth of clover.

You do not need to buy nitrogen for clover on a fairly rich soil. What would be needed would be supplied by the organic matter in the soil.

If the soil is in good condition you might use 300 to 500 pounds of dry hardwood ashes, (or 150 to 250 pounds Kainit) and 200 pounds of acid phosphate per acre. Sow both and harrow in, and when harrowed to a fine seed bed sow 16 to 20 pounds of red clover seed, and go over once with a light roller or light harrow, or if these are not at hand, a light brush. Sometime in August will probably be suitable to sow, but if a long dry spell follows, you may count on reseeding, in which case the surface must be reharrowed to a seed bed again.

In the ordinary commercial brands of fertilizers you pay for what is found in a ton, of each of the elements nitrogen, phosphoric acid, and potash. Now, on a fair soil, clover does not need purchased nitrogen, because after it gets started to grow it forms a sort of copartnership with another plant, a little microscopic plant, and "tubercles" are formed on the clover roots, and by some obscure means the two gather nitrogen from the air in the soil. Thus we see clover gathers its own nitrogen and much more of it than most of our other cultivated plants. This costs so little and the animal food-value of the nitrogen-compounds in the clover, and the plant food thus stored in the roots, is what makes the growing of clover so valuable to us. It is a nitrogen trap.

If a poor soil is to be used we must get organic matter into it for two reasons: To hold moisture for the plants and to encournge a process called nitrification and help on the clover and its friend by these favorable conditions. Stable manure plowed in furnishes the plant food and organic matter direct but is expensive. The cow-pea belongs to the same general family of plants as clover and, with its minute friend, has the greater advantage of being able to thrive on poorer land than clover can grow on. Then when the pea vines are ripe and plowed in and the clover seed sown on the well prepared surface, it vegetates quickly and as the young plants are susceptible to severe changes, a drought may kill them, or a crusted surface may prevent their coming up, or a minute hopping insect may come along in great numbers and eat off the tender leaves faster than they can grow. So a light top-dressing of stable manure which acts as a mulch to protect the plants from the sun, and hiding the soil prevents somewhat the drying out of the surface and brings some more plant food directly to the plants, which may help them to grow away from the insects if they are present.

The second best course is to plow the ground well and harrow in the fertilizer as directed. Clover not needing nitrogen, you can buy acid phosphate for the phosporic acid. The brand is immaterial. You need now potash Hard wood ashes contain 7 or 8 per cent of potash if not leached, and also lime and some phosphoric acid which is favorable for clover.

You burn wood and may have the ashes at home, or for a few cents per bushel can pick them up in the neighborhood, when you will have the best sort of combination of chemicals at the very smallest cost. Much now depends on your preparation of the seed bed. Harrow and sow as soon as the land is fit to work after a rain or good shower.

Identification of Grass.

I herewith send you specimen of grass growing in my fields. Please tell me name of said grass, etc. Any information will be thankfully received and appreciated by me.

The species has completely taken possession of my best wheat field. My land is well improved; will produce 25 bushels of wheat per acre. Would like to know method of ridding my fields of this pest without planting in corn. —H. D. H. Reedy Creek, Davidson Co., N. C.

(Answered by Gerald McCarthy, Botanist.

This is Poa compressa (English blue grass) a perennial grass of unsurpassed excellence for pasturage. It does far better than its sister species, Kentucky Blue Grass, on soils poor in lime, as most soils in this State are. While wheat is selling at present prices, you will probably find it most profitable to leave the field in possession of this grass and pasture it. For a fuller account of this grass see Bulletin No. 73

AMONG THE FARMERS.

The Agricultural Experiment Station at Raleigh, N. C.

Describes Some of Its Work—Read the Questions and Replies.

SEPTEMBER 16, 1893.

Publications of the Experiment Station.

They are free to residents of North Carolina. Apply to Dr. H. B. Battle, Director, Raleigh, N. C. Some late interesting bulletins are:

No. 89. Co-operative Field Tests during 1891 and 1892. A bulletin of 47 pages, containing the results of field experiments by practical farmers under the direction of the Station. These tests embrace fertilizer tests with cotton, corn and tobacco, together with variety tests of cotton and corn.

No. 81. Feeding Cotton-seed Hulls and Meal for the Production of Beef 28 pages devoted to the profit and loss of this feeding, and final encouraging results. All feeders for beef who use cotton seed products should have this bulletin. In this connection technical bulletin No. 4, on digestion experiments, will be found interesting.

No. 83. Growing Celery and the Cultivation of Onions. A practical treatise of 20 pages giving details of treatment.

No. 84. Some Enemies of Truck and Garden Crops. A bulletin of 26 pages giving the insects and diseases affecting beans, cabbage, celery, strawberries, and tomatoes. Also remedies for exterminating them.

No. 86. Tobacco Curing by the Leaf Cure and the Stalk Processes. Gives a description in 32 pages of the test to show the comparative results of the two methods of curing yellow tobacco. The leaf cure gave tobacco which sold at $63.14 for the half acre tested, while the stalk cure gave $38.29. Extracting the cost of curing, &c., not common to each, there was a net value of $20.66 for the half-acre in favor of the leaf cure. The bulletin describes all details from beginning to end.

Facts For Farmers.

A bulletin was written to be read by farmers. The subject was one which all farmers wish to learn more about, and was chosen for that purpose. It was written from the farmers' standpoint and will be supplied free to all farmers who write for it. If you do not want it, don't send for it.

The bulletin is No. 79, of 24 pages, recently issued by the N. C. Agricultural Experiment Station at Raleigh. Every man who farms should become acquainted with the structure of plants and the forces exerted by them in growing; how they take up food from the soil and air, and how they store it away, and the best plans for their cultivation and care; how stable manure may be preserved and utilized; how lime acts upon the soil, and what soils are most benefitted by its application. All these are treated in a plain, practical way in this bulletin. Green manuring is also fully described, as well as the value of recuperative crops and the proper rotation of crops. Some may say that a discussion of these matters is not truly experimental in their character, and does not belong in the bulletins of an experiment station. It is pretty well settled, however, from the favor with which the farmers have received this bulletin, that they appreciate its pages.

Farmers Who Read.

There are now on the mailing lists of the N. C. Agricultural Experiment Station, which have just been revised, 13,000 names of farmers from North Carolina. The bulletins are mailed free to those who request them and show their appreciation by reading them. All the newspapers in the state receive each publication of the Station as it is issued, as well as various news notes which interest the general reader. The bulletins contain matters which are of immediate interest and value to the agriculturists of the State and are written in plain language for unscientific readers. Agriculture is based on science, and accordingly scientific matters nesessarily receive attention at the Station. The result of these scientific experiments are not included in the general bulletin issue, but are printed in technical bulletins, sent only to scientists, and those who especially request them. Summaries of the technical work appear in the general bulletins of the Station. Publications are sent free to all within the limits of North Carolina upon application; to others a small fee is charged.

Lice on Chicks.

Lice and mites are cruelly tormenting to sitting hens, and destructive to the young chicks upon which they come from the mother hen.

A good remedy is the kerosene ointment. Formula No. 4 Bulletin No. 78 of the N. C. Experiment Station. This should be rubbed on the heads of chicks a week old, and sitting hens should be well rubbed with it under the wings and tail, when placed on the nest, and again as soon as the eggs are hatched.

This ointment may be used to rid dogs and other animals of parasitic pests. The ointment is made as follows:

Lard, - - -	1 pound.
Flour of sulphur, -	2 ounces.
Kerosene, - - -	1-4 pint.

Directions: Mix the lard and sulphur, then add the oil and thoroughly mix. Keep in a tight can or jar. Apply by rubbing—not for internal use.—Gerald McCarthy, N. C. Experiment Station.

Harvesting the Corn Crop.

There is a serious loss in harvesting corn in the usual way of pulling fodder and plucking the ears. Some recent Experiment Station work serves to bring this out in relief. Mr. J. H. Patterson, of the Maryland Station, publishes some matter showing the location of the dry matter of the corn plant in three crops examined. Coefficients of digestibility are given, with composition and total digestible product of ears, topped fodder, blades, husks and stubble. The results show the ears and blades to have been only 50.59 per cent of the dry matter of the crop. The other parts usually neglected by our farmers consequently amount to 49.41 per cent, or at least one-half.

Of the digestible matter 55.08 per cent only was contained in ears and blades. Thus nearly 45 per cent of the digestible matter of the crop would be lost by taking only ears and blades from the field.

The digestibility of coarse fodder, rich in carbohydrates, is greatly increased by feeding with highly nitrogenous materials, such as cotton seed meal. So it would be possible for one to get almost as much digestible food out of the corn stalk left to rot in the field as is saved from the crop in ears and pulled fodder.

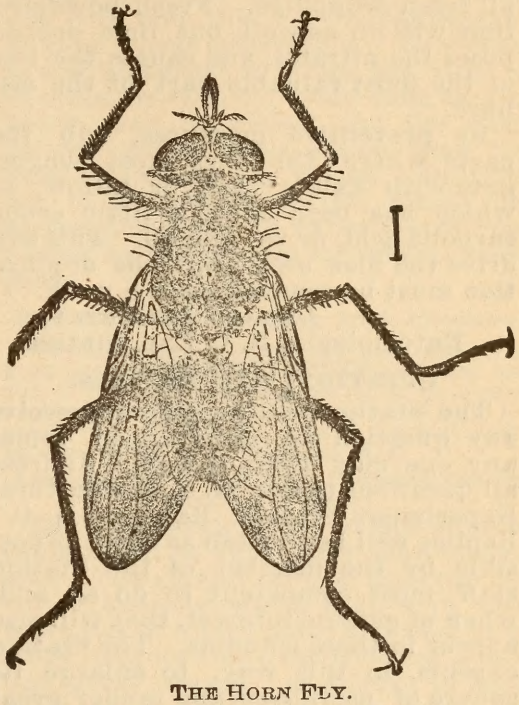
The simplest way to get the most food out of the corn crop is to cut close to the ground with short-handled hoes at about the time the fodder would be pulled, and cure in a silo. Lacking the silo, cut the corn in the same way a few days later, or about the time fodder is generally pulled, and shock in the field. Put 400 to 600 pounds in a shock, and stand the buts out open enough to make the shock stand firm and let in the air to dry the corn. Bind the tops tight to hold together and keep out rain.

When cured, shock out the ears, and cut what is left, known as stovers (the stalks, blades and shucks), into inch lengths. Feed to cows or work teams with cotton seed meal, wheat bran, or such other nitrogenous materials as can be most readily obtained. For nearly balanced ration, feed one pound of meal to four of stover and two of oat straw. The stover alone, fed freely, will support an animal at rest and not giving milk. F. E. Emery,
Agriculturist, N. C. Exp. Station.

The Horn Fly.

The horn-fly (hæmatobia serrata), an insect pest of cattle, has spread all over the Atlantic States from a single center near Philadelphia, in 1887. It is a well known pest of Southern Europe, and will probably prove more hurtful to the Southern States than to those having a colder climate.

The fly is about one-half the size of the ordinary house-fly, which it otherwise much resembles, but is more hairy.



The Horn Fly.
(The short line shows exact size.)

These pests settle on the coat of the animal, in some place where they cannot be reached by the tail or tongue, and then they bite and suck the blood. They often swarm in such vast numbers that the animals are rapidly depleted in flesh. Milk cows, especially thin-skinned Jerseys, suffer cruelly, and often fall off one-half or more in milk. The insect does not seem to trouble horses or other animals.

This fly lays its eggs in the fresh droppings of cows, and these hatch into tiny whitish maggots, which live in the dung three or four days. They then burrow a half inch or so into the ground beneath the manure, and remain quiet for about five days, at the end of which they emerge as winged flies. The number of generations in a season will depend upon its length. In the South there may be twelve or fifteen.

This fly has a habit of settling around the base of the cow's horns, which has led to many absurd stories about its eating the horn. The fly has no jaws. It can pierce with its lance, and suck with its proboscis, but never injures parts except where blood may be found. It settles upon the horns to

rest, as the cow cannot easily dislodge them from this place. When after food it settles, by preference, between the shoulders, along the belly and udder. Also, along the "escutcheon," and at base of tail.

Remedies: Remove all fresh droppings as soon as possible from stable. In pastures it will pay to send a man through every two or three days, and sprinkle kerosene oil or emulsion on all fresh droppings. Fresh powdered lime will do as well, but lime decomposes the nitrates, and causes the loss of the most valuable part of the manure.

As preventive measures, rub the parts where the flies most congregate with axle grease, or tallow, to which has been added a little crude carbolic acid, or use fish oil. This will drive the flies away, but the application must be renewed once a week.

GERALD MCCARTHY,
Entomologist N. C. Exp. Station.

QUESTIONS AND REPLIES.

The Station will be glad to receive any question on agricultural topics any one may desire to send. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render great assistance to practical farmers.

The Corn Bill-bug.

Enclosed find a little insect that is very destructive to corn on bottom lands and lands adjacent to lowlands. I wish to know their name and the best way of dealing with them.—D. C. M., Ashpole, N. C.

(Answered by Gerald McCarthy, Entomologist Experiment Station.)

The insects are the corn bill-bug, (sphenophorous sculptilis.) This is a semi-aquatic insect, which breeds in rotten, wet wood. It is never troublesome on high or dry ground. The remedy is drainage where possible, keeping low fields free from rotten wood, and planting corn only on uplands in localities where this insect is known to be troublesome. To save the present crop a small handful of the kerosene-lime powder, made according to formula No. 10 in bulletin 84 of this Station, may be dusted on each hill of corn, or along the drill. Paris green will do very little good in this case, and its use is not recommended.

What Season of the Year Is Best for Pruning Fruit Trees—Is It Advisable to Mulch Strawberries?

Please inform me what season of the year you regard best for pruning fruit trees, (peach, sherry and apple). I have some trees which need pruning, but do not know when to have them pruned with least danger to trees and fruit, also what kind of manure or mulching you would advise for the trees.

I have recently set out two beds of strawberries, of the Sharpless and Jumbo varieties; would you advise mulching them, that is, covering them with leaves or straw, and if so, when?

F. H. C., Shelby, N. C.

(Answered by W. F. Massey, Horticulturist, Experiment Station.

In this latitude any fruit trees can be pruned as soon as you choose after the fall of the leaf, but in the case of the peach I usually prefer to do the pruning in February, as then the character of the buds is more apparent. If fruit trees are properly pruned and attended to from the start, there will seldom be any need for heavy cutting. Pruning in the dormant season promotes more rapid growth. Too rapid growth is checked and directed by pinching the ends of growing shoots in summer. Our Station will soon have a Bulletin out on the subject of fruit culture, in which this subject will be more fully treated. Potassic manures are best for fruit trees in general. Bone dust and wood ashes are a good mixture. Mulching your straw berries will do no harm if not put on too thickly, and pine leaves or straw will be found useful in Spring to pull over the vines as a protection from threatened frost when in bloom, and will keep the fruit clean. But the mulch is not absolutely necessary as a winter protection here, as it is at the North.

Compost for Wheat.

I have a quantity of tobacco stems rotted and well pulverized by the aid of lime that I wish to mix with chemicals and drill with my wheat next fall. Please give me formula for making compost, using tobacco and lime. I want to drill all my crop of small grain and will follow clover sod. In rotting my stems, I used lime in limited quantity, and gave the heat my personal attention. It was not exposed to sun nor rain, neither did it suffer by over-heating nor drying. —W. H. S., Culler, N. C.

(Answered by H. B. Battle, Director Experiment Station.)

I would suggest adding—

200 lbs. - acid phosphate,
200 lbs. - decomposed tobacco stems

to the acre for your wheat. As it follows clover sod, the latter ought to give sufficient quantity of organic matter, including nitrogen, for the use of the wheat. I send Bulletin No. 91, which describes some wheat experiments which might be worth your while to try.

Bisulphide of Carbon for Stored Peas.

When bisulphide of carbon has been used for destroying the insects in buggy peas, can these peas be afterward fed to hogs with safety? Also, how much of the bisulphide should one apply to a bin of 100 bushels of peas?—G. B., Lexington, N. C.

(Answered by Gerald McCarthy, Entomoligist Experiment Station.

The use of carbon bisulphide in grain, peas, or any other food substance, has

no effect whatever upon the wholesomeness of the substance, provided that the carbon bisulphide is allowed to thoroughly evaporate before the substance is used for food. Usually two or three hours' exposure to the air is all that is needed.

The quantity of the chemical to use on 100 bushels of peas will depend somewhat upon the tightness of the vessel or bin in which the treatment is made. If you use a hogshead, or equally tight box, and cover with a heavy cloth (do not use rubber or oil-cloth), you will find three to four tablespoonfuls sufficient. Let the seeds stand covered for 24 hours, then expose freely to the air until no odor of the bisulphide is apparent. Beware of exposing this chemical to the fire—it is extremely explosive.

Clover For Horses—Grasses.

I have a patch of red clover, a half acre sown last October, which I have pastured all this year (Sept. 1). It is green now and affords a good bite. Two cows have grazed on it most of the time; it salivates horses. Is it best to let horses eat it at all?

Orchard grass and meadow fescue sown with the clover have not kept pace with it. Is it best to keep stock off now till later in the season? The land is good and convenient for winter grazing and I want to keep it in best condition for that purpose.—D. L., Bellair, Craven Co., N. C.

(Answered by F. E. Emery, Agriculturist Experiment Station.)

Keep horses off from rank, green clover or grass, or allow to graze sparingly, and feed dry hay once per day. Aim to top-dress with four or five cords of stable manure, evenly spread, and hold off stock only during dry weather, if it has been grazed short, so the sun will not kill the crowns. Top-dressing will bring out your grass, if it is alive, and you will be likely to find it holding its own with the clover for the year following the top-dressing.

Fertilizer for Wheat.

I have a five-acre field: pine growth; has been cleared three years; soil, sand; sub-soil, yellow. Has been in corn two years; wheat one year. What mixture must I have to make a good fertilizer on my wheat? I have stable manure and ashes. What fertilizer must I buy to make a dry mixture for the old field?—W. M. A., Greensboro, N. C.

(Answered by H. B. Battle, Director Experiment Station.)

I would suggest your using for wheat on the five-acre field a mixture composed of—

Stable manure, - - -	800 lbs.
Acid phosphate, - - -	800 lbs.
Ashes, - - - - - - -	400 lbs.

The ashes should be unleached and best of hard wood; the stable manure ought to be thoroughly rotted. In mixing, scatter a layer of stable manure, then a layer of acid phosphate, then ashes, and repeat in same order. When ready to apply, mix the heap thoroughly as you haul it to the field. It will be best not to let the heap stand long, because the ashes will have a tendency to decompose the manure. Application should be made at the rate of four or five hundred pounds per acre.

Have you ever tried the effect of a previous crop of cow-pea vines, to be plowed under when ripe? I think you will find this very advantageous to your wheat cultivation. Cow-peas, sowed broadcast in June, are ripe in October, or earlier. Such peas as you desire may be picked, and the vines plowed under, after which time the field is prepared for wheat. Bulletin No. 91 is sent herewith, which describes the detail of experiments conducted by the Station for several years past.

Best Method of Keeping Irish Potatoes.

Will you please give me the best method to keep Irish potatoes from rotting after they are dug, if you have such information at your command. I want to put them up so as to keep for winter use. This is why I want the best method to do it.—P. A. B., Durham, N. C.

(Answered by W. F. Massey, Horticulturist Experiment Station.)

Early potatoes grown in this climate cannot well be kept later than Christmas. You should raise a fall crop for winter keeping, which keep with ease when put in a dark place and kept only a few degrees above the freezing point. One great reason for failure to keep potatoes is that they are kept too warm. A cold that will make ice on water will not hurt a potato in a barrel. If they could be kept in a uniform atmosphere of 33 to 35 degrees, they would be all the better. Another reason for failure is keeping them in too light a place. Potatoes should be kept in total darkness, and should be put into total darkness as soon as possible after digging. Not a ray of sunlight should be allowed to reach them at any time. A few hours sunning in the patch, while digging, will spoil the best Irish potato. The early crop may be kept until the late crop is ready, by careful management. Dig them when the soil is dry, and at once spread in a cool dark cellar. In a few days overhaul them, and pick out the rotten ones, and then sprinkle air-slacked lime all through the heap, and do not pile too deeply. If kept cool and dark, they will do until Christmas, when they will soon get worthless from sprouting.

OF INTEREST TO FARMERS.

The N. C. Agricultural Experiment Station at Raleigh,

Offers to Send Its Bulletins Free To All Farmers in North Carolina Who Request Them.

OCTOBER 14, 1893.

The Experiment Station Has No Money

To throw away. So if you are not going to read carefully the bulletins and other publications, do not ask for them. These publications costs a great deal of money, and the Station can afford only to put them where they will be appreciated. If you really desire to receive and read and profit by them, you will be cheerfully supplied with any particular past bulletin, and all future issues, if you write to Dr. H. B. Battle, Director, Raleigh, N. C., for them.

As An Example

of the cost of some of Experiment Station bulletins, let us look at Bulletin 92, "The Culture of Orchard and Garden Fruits," which is just received from the printers, and is ready for issue now. There are 148 pages—the largest bulletin the Station has yet published. Bulletin 73, "The Best Agricultural Grasses," is the next in point of size, and has 100 pages. The edition of No. 92 is 14,500 copies. The paper necessary to print this number is 143 1-2 reams, and weighs 7,168 pounds, or over 3 1-2 tons. If this paper were spread on the ground one thickness, it would cover an area of 48,435 square yards, or about 100 acres. If the separate sheets of the entire edition of the bulletin were put end to end, they would extend a distance of 268,250 yards, or 153 miles—or from Raleigh to Richmond, Va., in a straight line.

The Depth to Plant Wheat.

The result of an experiment made by the N. C. Agricultural Experiment Station at Raleigh to test the best depth to plant wheat is as follows: The average yield per acre when plated at a depth of two inches was 24.5 bushels; planted three inches deep, it was 32.1 bushels per acre; four inches, 23.7 bushels per acre. It will be seen, therefore, that the decided preference lay with the three inch planting. In this test, the seed was planted very late, on the 24th December, after turnips had been taken off the land. The depth of planting was carefully gauged by a dibble. The best stand on the following 28th March was noted on the shallow planting, and the more scattering stand on the deepest planting, though the plants on these last were almost as large and vigorous as the others. It is probable that with an earlier sowing the result of the deepest planting would have been more favorable.

Grazing Rye and Barley.

How soon land may be grazed after sown to rye and barley for this purpose depends on uncertain conditions—the main items of which are the weather and state of fertility, and moisture of the field in which the grains are sown. If favorable weather accompanies and follows the deposit of the seed in a rich moist soil, it will be nicely vegetated within a week, and by one or two more weeks might be lightly cropped if desired. But if the gronnd is soft it would be best to hold stock off until the plants have tillered, and are covering the ground with a green carpet, which will take several weeks more. Four to six weeks may be soon enough to begin grazing, regard being made to growth and best treatment of the plants grazed.

How much grazing can be done on a given area is quite as uncertain and depends on the same conditions. The judgment of the grazier in removing the stock when the roots are likely to suffer from exposure to sun or teeth by too close cropping, or when by packing the too wet soil harm may be done, is also an important factor in this case. The skill with which the stock is handled and numbers apportioned to keep the growth cut off enough not to out-grow a good feeding height, and avoid cutting too short and packing, will be the controlling factor after grazing has begun. —F. E. EMERY, Agriculturist, N. C. Experiment Station.

Fruit Culture.

A bulletin (No. 92) is now ready for mailing, on the subject of fruit culture by the N. C. Agricultural Experiment Station at Raleigh. It contains 148 pages and is improved by having 91 cuts to illustrate the various subjects. It is very comprehensive in scope, embracing two general heads. The first imcludes propagation, planting and culture of fruit trees and fruit-bearing plants, and the preservation and shipping of fruits. The second head embraces insects and diseases affecting fruit trees, plants and fruit, with remedies for their destruction. The publication is copiously illustrated with cuts showing how to graft and propagate fruit trees and vines and train and prune them; also cuts of insects and how diseases effect them, together with appliances to destroy these enemies. It is a manual for growing fruit trees and keeping them, as well as for the care of fruits in reference to gathering, packing, shipping, drying,

preserving, and canning them. Varieties of fruits are described, as well as those most suitable to various sections of North Carolina.

This publication will be sent free to all residents of the State who apply, and to outsiders who send 10 cents in stamps. Apply to Dr. H. B. Battle, Director, Raleigh, N. C.

Fall-Grown Irish Potatoes.

Few of our people fully realize the long keeping quality of our Fall-grown Irish potatoes, We have now (Sept. 16) at the Station farm potatoes raised in the Fall of 1892 that are still sound. They are now somewhat shriveled and sprouted of course, but the fact that they are still sound and capable of growing, is significant. If we can succeed in keeping over these Fall-grown potatoes in perfect shape until, say the last of July, and then use them for seed, we feel sure that the late crop can be made a more certain one. Sometime since, a gentleman in Virginia sent me some of his Fall-grown potatoes he had kept over for seed. They were smooth and firm, with the eyes just fairly started. He wrote me that his plan was to keep them in a cool, dark cellar as late as possible, but as soon as they show signs of sprouting to remove them at once to a dry, light place, and spread them out. This keeps the eyes from drawing out into long shoots, and they start with a stout green growth but elongate very slowly, and the sprouts are so firm that they can easily be handled and planted in July. We propose to experiment in this direction and hope some of our readers will do likewise, and report the results of planting these potatoes in comparison with the seed of the same season's growth.—W. F. Massey, Horticulturist, N. C. Experiment Station

Practical Stock-feeding.

This is the title of a bulletin (No. 90) recently issued by the N. C. Experiment Station, which will be sent gratis to all residents of the State who apply. It is, as it name signifies, a discussion of stock-feeding from a practical standpoint. The scientific questions involved are not neglected, for every practical subject is based upon scientific facts, and a full understanding of one involves a knowledge of the other. All stock feeds are not the same in quality; some are richer in some ingredients than others. These ingredients when eaten in food act differently in building up the body. Some make flesh, some make bone, some make heat and force. Foods, therefore, vary greatly in value for different purposes. Again, the constiuents may not wholly be available to the animal. A portion of a certain constituent may be easily digested, while the other part may pass entirely through and go off as waste. If the manure is not preserved, it is really an absolute waste. The digestible portions of the various constiuents must be determined by actual feeding tests with animals, while the constituents must be carefully analyzed chemically. By actual feeding it has been ascertained what quantity of these digestible constituents is needed for different purposes of feeding to produce fat, or growth, or sustain vigor when worked. In this way we can lay down a rule for feeding animals, and knowing the foods we have at hand, and the indigestible proportions, it will be easy to combine them according to the desired rule. To simplify and explain the subject thoroughly in a plain, practical way, is the object of the above bulletin, which is written by B. W. Kilgore, Assistant Chemist.

North Carolina has, according to the last Auditor's returns, 133,784 horses, 110,700 mules, 646,241 cattle, and 1,292,856 hogs. There is no question but that vast quantities of food are wasted annually by improper feeding. If we suppose that fifteen cents per month is so wasted for each animal, and this sum is entirely within reason, we have the total of $3,948,445.80 per year, which is approximately one-sixtieth of the assessed value of the total real and personal property of the entire State. Ought not stock-feeders, therefore, to carefully investigate these questions?

Teaching the Calves to Drink.

The successful calf feeder will always use more tact than force in learning a calf to drink. He will never allow a foolish calf to betray him into a passion or display of brute force. Do not allow the calf to suck the whole hand, or a single finger, but placing the palm of either hand over its nose, gently bring it to the milk held in a convenient sized pail in the other hand. By separating the fingers, hold back the sides of the tongue and insure the entrance of milk as the calf sucks. If the milk is warm there will be less trouble, then give the calf more, or less, of the two fingers, according to success in keeping it interested in the milk. When the calf is doing well the fingers will scarcely be touching its tongue or lips. If it acts badly give the fingers to suck and contrive to let in a dash of milk so a sup now and then will encourage the calf to continue.

I have been obliged to dip my hand repeatedly into the milk and thus give a taste of it before the calf would allow its nose to be turned down into the pail. Some calves will drink during the first to the third trial, while others will need

the fingers for a much longer time.—F. E. EMERY, Agriculturist, N. C. Experiment Station.

Care of Stock in Winter.

Soon will be the time when stock-owners can make some valuable trials for themselves in testing the value of advice given for winter care of stock.

Of two or three milch cows try giving one a comfortable stall well lighted and ventilated without holes for cold drafts or rain to enter, and keep her dry and clean. Turn the others off in the usual way, and compare food eaten and milk produced, and remember that there is left in the stall a compost worth over five-sixths of all the fertilizing elements in the food, and all well preserved.

Try other stock in the same way, and it will be found to pay well in growth and compost made.—F. E. Emery, N. C. Experiment Station.

QUESTIONS AND REPLIES.

The Station will be glad to receive any question on agricultural topics any one may desire to send. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render great assistance to practical farmers.

Feeding Pigs.

I have been told by a successful hog raiser and farmer that cotton seed boiled with cymlings and Irish potatoes is a good feed for growing hogs. Will you kindly give me your opinion, as I have a lot of both and wish to save corn.—J. R. W., Enfield, N. C.

(Answered by F. E. Emery, Agriculturist Experiment Station.)

Cymlings, or squash, and Irish potatoes are both good food for hogs, and the addition of cotton seed boiled in would make a very desirable feed if the cotton seed can be risked.

Cotton seed is not regarded as good food for swine. We have fed cotton seed meal to a pig until sick, and there was less growth than from a litter mate without cotton seed meal. The pig recovered its health, but was stunted.

The Texas Experiment Station has made some decisive experiments with cotton seed fed with corn to pigs, and in every case fatal results were found after six or eight weeks feeding on the cotton seed ration, but pigs that passed the ten days, at which others sickened and died, seemed to be not liable to attack. The cotton seed meal was fed raw, boiled and roasted, with corn and water as wanted. The boiled seed was less dangerous than the other forms, as indicated by a lower death rate among the pigs to which it was fed.

It may be that the bulk of the food you propose, or some counteracting compound in it, may overcome the dangerous toxic agent of the cotton seed. Your friend doubtless speaks from experience, and if he has fed this ration largely, you may have the assurance of his practice if none of his stock died while so feeding. It will at least be well for you to know that cotton seed is dangerous, so as to be on the watch for dangerous symptoms if you feed it.

But why feed an article in which danger lurks? You have other stock which can use the cotton seed in rations and it will do no harm. Then you can feed corn to the pigs at a more profitable rate of production of pork than you could feed the cotton seed ration. Put your corn with the cymlings and potatoes and you will be handsomely repaid if you feed the pigs all they can consume in comfortable quarters.

We should prefer to grind the corn and mix the meal into the boiled mash of cymlings and potatoes while hot, so the meal would get moistened and the starch grains cracked by the heat. Wheat bran, middlings, or rice polish might be used to grow the pigs, and then the corn meal used as a finisher to fatten them.

New Forage Plant—Hatching Eggs With Incubator.

I see an account of a new forage plant in a paper called "The Irrigation Age," which has been discovered in Germany. It says that it is one of the best forage plants that is known. The botanical name given it is Lathyrus silvestris. Do you know whether this plant has been experimented on by any of the Experiment Stations of the United States? If it has what was the result?

I should like to have your opinion as to whether or not it will pay to run an incubator for the purpose of raising chickens for the market when grown ones are only worth 25 cents a piece?—H. S. P., Clark's Mills, N. C.

(Answered by F. E. Emery, Agriculturist N. C. Experiment Station.

Lathyrus silvestris has been experimented with by a number of American Experiment Stations, and at least one has published its chemical composition in a bulletin on that plant. From accounts of it, this plant should rank with Medicago sativa, Lucerne or Alfalfa, which is a perennial and yields two or three cuttings per year. Lathyrus silvestris seed, however, can hardly be worth the price $3.50 per pound in 10 pound lots in New York city for common use, while we have the clovers, Lucerne and corn, the seed of which we can raise freely.

It will pay to use an incubator to hatch chicks if you learn to handle it right and use a good kind of brooder after chicks are hatched. This is especially applicable if your chicks can be sold for broilers at 25 cents each. You

can supply chicks for the market by incubator and brooder when prices are best and perhaps realize more than the prices given.

Treatment of Peach Trees.

What is the best method of preventing peach trees from breaking.—W. E. J., Kingwood, N. C.

(Answered by W. F. Massey, Horticulturist Experiment Station.)

Peach trees usually break down because of neglect in pruning and shaping the young tree. The peach bears its fruit upon last years shoots. If the growth is neglected the fruit bearing wood gradually gets further and further out on the ends of the limbs, and the weight of the crop has a tremendous leverage, and splits the limb off. When we plant a young peach tree, of one years growth from the bud, (the only age at which they should be planted) we cut the stem back to about eighteen to twenty inches from the ground. When growth begins in spring, we rub off all the shoots except three or four at top, which form the limbs for the future head. These are again shortened back in the fall one third, and when the shoots are too thick in the interior of the head and interfere with each other, they are trimmed out. Every fall the young growth of the season is shortened back one third, and care is taken to maintain an even distribution of young wood all through the head of the tree. The crop is thus distributed over the tree and no damage is done. If the tree is planted and allowed to take the natural shape it assumed in the nursery, the limbs will more readily split off than when formed by heading back.

Sowing Crimson Clover on Weedy Land.

We have a piece of strong land on a river bank on which there is a very rank growth of weeds. We wish to know your idea of growing annual clover on this land; what preparation should be given and how should the seed be sown.—T. R. P., Corinth, N. C.

(Answered by F. E. Emery, Agriculturist North Carolina Experiment Station.)

If it were not for seeding with the weed seeds you might sow the clover among the seeds broadcast if the soil is light and save working the soil.

It will be best to mow the weeds or roll down with a heavy roller a few days in advance of plowing in order to let them partially dry out, and not endanger sowing the land by turning down a great mass of green matter fermenting in it. Plow well, harrow smooth, sow clover seed broadcast at the rate fifteen, eighteen or twenty pounds per acre of clean seed, or forty to fifty of chaff per acre. Then drag with a light brush, smoothing harrow, or a plank with a chain attached to both ends and the singletree, so the plank will cover nearly its whole length on the ground, Watch your field, so if seed germinates and is killed by hot weather or insects, you can re-harrow and re-seed.

Fertilizer For Wheat.

I have a piece of land that has been growing old field pines, but was never worn out, that I wish to burn off and sow in wheat this fall. The pines were cut down last winter. It is a grey soil with red subsoil. Now I wish to know if cotton seed meal would increase the yield of wheat and how much per acre; if not, what fertilizer would be best and how much? The soil is not very deep but I wish to improve it.—R. A. B., Brower's Mills, N. C.

Answered by H. B. Battle, Director North Carolina Experiment Station:

I would advise the use of the following mixture for your land for wheat:

Acid Phosphate - -	1000 lbs.
Cotton seed meal - -	700 "
Kainit - - - - -	300 "

I would not use less than 300 lbs. of this mixture per acre. I have employed the most common of the fertilizing materials for this mixture, as being more convenient to procure them. A pamphlet on the subject of "Composts" sent by this mail will give other formulas.

A previous crop of cow-pea vines plowed in before wheat has been sown is of great value in adding fertility to the soil. Bulletin No. 91, which is sent you, describes their effect.

Keeping Qualities of Kainit.

It is claimed by some that age deteriorates the manurial value of Kainit, and in order to satisfy us, kindly let us hear from you in a positive statement if so or not.—I. W. S., Cedar Point, N. C.

(Answered by H. B. Battle, Director North Carolina Experiment Station.)

There are no constituents of Kainit that would injure on standing or keeping over from one season to another. The objection would be more in the mechanical properties than in the chemical, as age would cause the Kainit to become more or less lumpy or moist. The magnesia salts, especially magnesia chloride, have a special tendency to absorb moisture from the atmosphere and cause the whole mass to become somewhat wet. This causes the caking and if a large quantity of moisture be present, it might, under these favorable circumstances, dissolve some of the Potash, but this would hardly happen sufficient to leach off any of the Potash material.

The Apple Tree Root Louse.

I shall set out 2,000 apple trees this spring, which are now in nursery. The roots of some have the Aphis on them. I thought of dipping the roots into hot water 120 degrees F. What is the best and quickest remedy?—C. C. B., Clayton, N. C.

(Answered by Gerald McCarthy, Entomologist Experiment Station.)

The hot water treatment will hardly prove successful and is likely to injure the trees if the weather should be cold. The best remedy is the Tobacco decoction made according to formula No. 8, Bulletin No. 84 of this Station. This should be used cold and will not only destroy the lice but will also serve as fertilizer for the trees.

AGRICULTURAL COLUMNS

From the N. C. Agricultural Experiment Station at Raleigh.

Its Bulletins are Free to Those Who Apply in North Carolina, and Who Will Read Them.

NOVEMBER 18, 1893.

The Relationship of the State Weather Service to the Agricultural and Horticultural Industries of North Carolina.

By H. B. Battle, Director N. C. Agricultural Experiment Station.

[The State Weather Service is organized as the Meteorological Division of the Experiment Station.]

One of the principal objects of the establishment in 1886 of a Weather Service in North Carolina was for the material and immediate benefit to the agricultural and horticultural industries of the State. It is true that other results were sought and desired, such as a more perfect knowledge of our climate as a whole, by sections, and by separate localities. For in this way, besides giving prominence to our unexcelled climate—the cream of America—the knowledge thus gained could be utilized in possible adaptation of field and garden crops from other portions of our own, or of far-off countries.

With the exception of one field crop—tobacco—there are none of the staples liable to be materially hurt by a sudden and decided change of the weather. With fruit and vegetables the case is quite different, especially during the early spring, when the liability of a biting frost is great, when the tender buds, leaves and flowers of fruit trees and small fruits can be most easily affected, and early vegetables of the trucker are likewise at its mercy; then it is that a foreknowledge of the coming of cold waves and frosts is of the greasest advantage. It is here that the State Weather Service lends its aid to the trucker and fruit grower, in addition to the tobacco grower, by informing them of the likelihood of sudden changes in atmospheric conditions, and thus gives forewarning of their advent.

Twenty years ago it would have seemed chimerical to have supposed that distant points could be told that a frost was expected there thirty-six hours afterward, yet now such is the efficiency of the U. S. Weather Bureau attached to the Department of Agriculture at Washington, and the facility and accuracy with which the state of the weather is gathered by telegraph from most distant as well as nearer points, and such is the knowledge of the science, and the ability of those engaged in digesting this information, that different sections of our common country are brought in the focus of this investigation, and predictions are made with almost startling accuracy.

The weather Bureau gathers these data, and sends the predictions suitable to various portions of the country—to different states having Weather Services, and these in turn transmit them to separate stations throughout the State. The system of collecting meteorological data originated with the U. S. War Department as a military necessity. By this means meteorological records from most distnat points on the frontier posts of the extreme west, at that time connected only by a telegraph line with civilization, were secured and invaluable knowledge gained of the rise and progress of cold waves having their origin in those bleak regions. As I write now in the latter part of October with an outside temperature of 52 degrees F. in Raleigh, we have knowledge of 12 degrees F. in North Dakota. With this knowledge a frost prediction was made for this locality two days ahead, which prediction was subsequently amply fulfilled. The Signal Service of the War Department became in this way of such great value as an institution in peace, especially to the agricultural operations of the country, that it was decided to greatly facilitate its labors, and to transfer it to the U. S. Department of Agriculture, and the Weather Bureau was then formed. The State Weather Services co-operate with the central Bureau, and are indebted to it for facilities and the means for conducting most of their operations.

The N. C. State Weather Service organized as the Meteorological Division of the N. C. Agricultural Experiment Station embraces in its work:

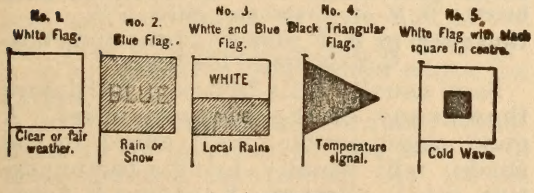
1. The Collection of Meteorological Data. Sixty-two voluntary observers throughout the State co-operate in recording local observations and the result of these data is printed in a monthly meteorological bulletin. These in turn make up the annual summaries for the State. The annual means for different stations and districts are combined, covering many years, to form normals. At some of the stations, records are preserved running back sixty or seventy years with few breaks. The normal pressure for the State is found to be 30.08 inches. The normal temperature is 59 degrees, almost exactly that of the Northern Hemisphere. The normal rainfall is 53.29 degrees.

2. The issue of a Weekly Weather Crop Bulletin. Reports are sent in from April to October from 270 observers representing 91 of the 96 counties show-

ing the effects of the weather upon the growing crops. These reports are embodied in the weekly crop bulletin.

3. Distribution of Daily Weather Forecasts, Cold-wave and Frost Warnings. It is under this section that the agricultural and horticultural interests of the State are mainly benefitted. As was previously said, the knowledge of forecoming frosts and cold waves is of great value to the trucker and fruit grower and tobacco grower. It enables him to prepare for its reception, to cut his tobacco and protect his small fruits and trucking crops, as well as his fruit trees. The Weather Service has in this way often saved crops in many localities, and seeks to extend further its usefulness. Daily forecasts and special warnings are sent daily except Sunday by telegraph to 55 points. Thirty additional points receive frost warnings only between March 15 and May 15, and in the Fall to November 1. In order that stations may be supplied with telegraphic messages, it is necessary that the point be reached by the Western Union telegraph, and that signals be shown to disseminate these forecasts. In addition to the telegraphic service, many near-by points are reached through the mails, and 281 stations are thus supplied. After reaching a station, the information is disseminated in three ways: first, by posting the telegram; next, by hoisting of flags; and last, by whistle signals. The hoisting of flags is the most common for every-day practice. Four flags 6 by 6 feet are used: the white for fair weather, the blue for rain, the black triangular for temperature, and white with black centre-square for cold wave. An additional flag is sometimes used, a combination white and blue for local rains. The cut below shows the appearance of the flags.

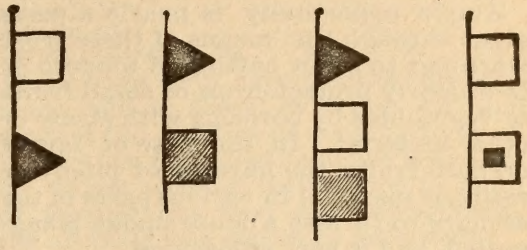
WEATHER FLAGS.



EXAMPLES:

No. 1, alone. indicates fair weather, stationary temperature.
No. 2, alone, indicates rain or snow, stationary temperature.
No. 3, alone, indicates local rain, stationary temperature.
No. 1, with No. 4 above it, indicates fair weather, warmer.
No. 1, with No. 4 below it, indicates fair weather, colder.
No. 2, with No. 4 above it, indicates rain or snow, warmer.
No. 2, with No. 4 below it, indicates rain or snow, colder.
No. 3, with No. 4 above it, indicates local rain, warmer.
No. 3, with No. 4 below it, indicates local rain, colder.
No. 5 is the cold wave flag and indicates that the temperature will fall 20 degrees or more to a minimum of 32 or less.
No. 5 is either displayed alone or with No. 1, and when displayed with No. 1 indicates fair weather, cold wave.

DISPLAYED FROM POLES:



Fair w. Colder. | Warmer. Rain or snow. | Warmer, f. w. followed by rain or snow. | Fair w. Cold wave

Steam whistle signals are oftentimes valuable for disseminating information, a code being used for the purpose, as follows:

CODE.

Blasts:	One long,	indicates	fair weather.
	Two long,	"	rain or snow.
	Tnree long,	"	local rains.
	One short,	"	lower temperature.
	Two short,	"	higher temperat're
	Three short,	"	cold wave.

In some states, passenger trains show flags. and are effective means for distributing the information. The firing of cannon, beacons at night, or smoke in day-time, can also be made useful in flat regions, but for undulating or hilly localities these plans are not successful.

The weather telegrams are now distributed about mid-day and give the forecast for the following day. The 8 A. M. meteorological observation from every weather bureau station in the United States is sent in cipher to Washington, is there translated, combined with contiguous as well as distant territory, studied in connection with the previous day, and the result at last reached giving the forecast of the weather, progress of a cold wave or storm, etc. Of course separate forecasts are made up for each State, and oftentimes for two or more districts of the same State. The accuracy of these predictions is in many cases astounding, and the average verifications are more than 80 per cent of the whole. The progress of storms and cold waves are more accurate still, as may be supposed, being dependent upon actual measurement of distance, rate of traveling, and obstructions likely to be enconntered.

It may be of interest to give below a cipher telegram and its translation sent from the Raleigh station, giving the 8 A. M. observations on November 1, 1893:

(CIPHER DISPATCH.)

RALEIGH: GELFIN. DUCK. EFFACE. CASUAL. SIXTY. FIFTY-SIX.

(TRANSLATION.)

"Raleigh: Barometer reading 30.44 inches,

thermometer reading 36 degrees; direction of wind N. E., state of weather clear, no rainfall past twenty-four hours; current wind velocity four miles per hour; minimum temperature past 24 hours, 32 degrees; 8 A. M. observation, relative humidity, 80 per cent. Mean temperature for October, 60 degrees; total precipitation for October, 5.60 inches."

Ample opportunity is nearly always given through the means of these frost warnings to allow cutting of tobacco or to properly protect crops of small fruits or vegetables by covering with straw or other material. In the case of larger orchard fruits, the burning of pitchy or resinous material in various parts of the orchard to furnish a dense smoke is suggested, and is very efficacious.

The State owes much to the assistance and co-operation of the U. S. Weather Bureau in this important and very useful work. For without this cordial assistance at all times given, the State Weather Service would never be able to render the timely and very material aid it now furnishes ro the agriculturists and horticulturists of North Carolina.

Evaporated Sweet Potatoes.

Few people know how easily sweet potatoes can be dried, even in the sun, and how handy and useful the dried potatoes are. At best sweet potatoes are a troublesome crop to keep, but when dried or cured in an evaporator they are really no trouble to keep and are always at hand for use on the table at short notice. They should be sliced and then evaporated. Then to use them they are soaked to restore the evaporated moisture and then baked in pans as the fresh ones often are. They are an admirable article for puddings and pies. For this purpose it would be better to grind them into meal and put up in packages with directions for making puddings. Put up in this way it ought not to be much trouble to create a market for the dried sweet potatoes. If an evaporating plant would but undertake the putting up of the sweet potato meal in packages the article would sell well. Grocerymen are slow to take hold of such products in the crude evaporated state, but in such packages, with a few attractive hand-bills and a lot of receipts for making the many delicious preparations that can be made from sweet potatoes, a market could soon be made for a product that Eastern North Carolina can supply in limitless quantities. Who will start this enterprise? W. F. Massey N. C. Experiment Station.

Marketing Stock for Beef.

Much of the stock carried to markets for sale is poor or not more than half fat. In this condition it is unfit for the butcher's use and brings but a small price. The same animal fed six or twelve weeks will be much heavier and at the same time will be worth more per pound. It will also have left fertilizer of great comparative value as a result of the fattening.

Bulletin 81 of the Experiment Station, distributed some time ago, shows some of the benefits of this kind of feeding. More work in the same line will soon be reported. There is a small profit in this feeding which farmers can not afford to lose. They must consider the matter and put it into practice or lose entirely the best markets. Most of the good beef is now raised and fed outside of the state and shipped here, instead of as should be, shipments of good beeves going from this state.

Why can we not supply home markets with salable products of good quality in this line in sufficient quantity to supply the demand? It can be done. Fatten well the stock to be sold and watch the market for the best price and see to it that the stock is as fat as desirable. Then it will bring the most per pound and weigh the heaviest.—F. E. Emery, Agriculturist, N. C. Experiment Station.

QUESTIONS AND REPLIES.

The Station will be glad to receive any questions on agricultural topics any one may desire to send. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render great assistance to practical farmers.

A Market For Herbs.

Can you inform me where I can sell herbs, such as garden sage, at? Give me some good house.—B. M. B., Freeman's Mills, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

Sage usually sells better in Baltimore than in any of the northern cities. A good clean article, well cured in the shade, will usually bring a remunerative price. Messrs. J. Staum & Sons, Light Street Wharf, an old and reliable commission house, will handle it for you as well as any one. I shipped a great deal to them years ago, and never had the slightest ground for complaint in their dealings. Reliable commission men are not plenty, and those who are should be known. Messrs. Wallace Bros., Statesville, N. C., are very extensive dealers in roots and herbs, and may handle your garden sage.

Keeping Sweet Potatoes Through Winter.

I have seen several of the "Press Bulletins,"

and am very anxious to have them regularly sent me. If you have ever published a method of keeping sweet potatoes through the winter, I should like to have that issue also.—Mrs. W. H. H. G., Statesville, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

The following method I have found to keep sweet potatoes in perfect order until June. Procure a good supply of pine straw from the woods in a dry time and keep it under cover ready for use. Dig the potatoes as soon as frost cuts the vines. If not convenient to dig at once, cut the frosted vines off at once, or they will harbor fungus growth that will damage the potatoes. Dig on a warm sunny day—lay the potatoes along the row as dug, and do not allow them to be bruised by throwing into piles. Handle at all times as gently as eggs. Allow them to lie in the sun during the day, and in the evening haul to a convenient place. Place good layer a foot thick of pine straw on the ground, and on this pile the potatoes in steep heaps, not over 25 bushels in a pile. Cover the piles thickly all over with the dry pine straw—now build a rough board shed over the piles, and let them remain until the weather grows colder, or until they have gone through a sweat and dried off. Then cover the heaps with earth six or eight inches thick and beat smooth. The important points are the sweating under the previous cover of the pine straw before covering with earth, very careful handling, and the board cover overhead. Dry earth keeps out more cold than wet earth. If for family use, put in smaller piles and take up an entire heap at once for use, keeping them in a dry warm place while using.

Rations for Fattening Pigs.

(Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.)

J. D. G., Lexington, N. C.: Your ration referred to below is a very good one, and calculated to grow and fatten the pigs well and fast, but as they get heavier, however, you should widen the ration.

Do this by increasing corn and wheat bran in proportion to pea meal, and then increase corn alone. At 125 lbs weight, the standard calls for ratio between protein and carborhydrates in the food equal to 1 to 5 1-2. Your ration is now about 1 to 3 3-4 or too narrow for the size of pig, weighing probably 50 lbs. More corn would suit better now for a short time. Then increase bran to 100, pea meal remaining 50, and corn to 200 lbs. The first change raises the ratio to about 1 to 5 1-4 and the last 1 to 6 1-4. You can make one or two intermediate ratios to advantage and get the pigs on the widest ration with the new lower cost corn. Changes may be thus:

	No. 1, 75 lbs. w'ght	No. 2, 100-125 lbs. w'ght	No. 3, 125-150 lbs. w'ght	No. 4, 150 200 lbs. w'ght	No. 5, 200-250 lbs. w'ght
Wheat bran	50	50	100	75	100
Pea meal	50	50	50	50	50
Corn meal	50	75	100	150	200
Ratio: 1 of Protein to Carbohyd'ts	4¾	5¼	5½	6	6¼

There have been experiments carefully made which show evidence for and against the practice of cooking food. I believe the strongest evidence is against it. Some careful tests were in favor of feeding the food dry and allowing the animals free access to pure water.

Self-sucking Cows.

How to break a half-blood Jersey heifer of sucking herself?—F. E. R., Asheville, N. C.

(Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.)

We would not attempt a cure on an animal of ordinary value. Side bars or nose contrivances will prevent the sucking but an ordinary beast is not worth the trouble entailed. It is probably one chance in ten if your heifer freed from the habit will yield enough to pay cost of feed and risk and pay for herself. Then add the trouble and expense to overcome a vicious and vexatious habit it is too much. We advise you to beef her on one of the rations in Bulletin 80 p. 14, and put the beef money into a young cow free from bad habits. If the cow was a full blooded and registered animal it would be a different matter, but for inferior stock it is not worth the trouble. If you desire to save the heifer and keep on the side bars continually for a long time, two or three years, she may forget it but the first act of licking an itching place may recall it even then, and your trouble be all for naught.

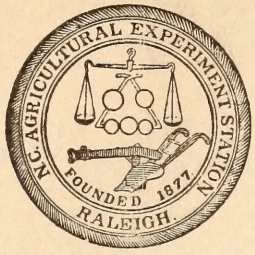
Indian Pipe or Fit Root.

Please send name of enclosed plant, which grows in bunches on my farm in places where mushrooms are abundant. It has no leaves and does not grow larger than specimen.—M. R. R., Powellville, N. C.

(Answered by Gerald McCarthy, Botanist, N. C. Experiment Station.)

The plant is monotropa uniflora, commonly called Indian pipe and Fit Root. It lacks chlorophyl, the green coloring mother of plants, and is therefore unable to assimilate food from the air and soil. It lives as a parasite on the leaves of pine trees. This plant is highly esteemed by homeopathic physicians as a remedy in epilepsy and in consequence has a high commercial value where it occurs in any quantity. Borricke & Fofel, pharmacists of Philadelphia deal in it. Before collecting it for market it will be well to communicate with this firm.

THE EXPERIMENT STATION



At Raleigh, N. C., Is Ready to Help the Farmers,

By Advice as to Agricultural Subjects—By Co-operation in Other Ways, or by Sending its Publications to Those Who Really Desire Them.

DECEMBER 24, 1893.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the Station to all in the State who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited by them, please do not apply for them. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Clover Seed Cleaned and in the Chaff.

As farmers sometimes wish to purchase clover seed in the chaff, or sow home-grown clover seed without hulling it, the relative value of the seed in these conditions should be understood. Examination of several samples of such seed at the N. C. Experiment Station gives the following results:

100 seeds of red clover in the hull weigh 0.40 gram. The hulls of 100 seed weigh 0.10 gram. The weight of the hulls is 1-4 or 25 per cent. of the total weight of unhulled seed. Out of 100 apparent seeds in hull 28 seeds had no germ. Out of a weighed sample of unhulled seeds 1-4 the weight was chaff, dirt and weed seeds. In a sample of choice cleaned clover seed we expect to find the viability of seed 95 per cent. Real worth 90,25 per cent. Assuming that in the unhulled sample as great a per cent. of true seeds will germinate as in the sample of choice cleaned seed, we calculate the real worth of this sample as 38.85 per cent. Therefore in purchasing clover seed in the hull the price should never exceed 40 per cent. of the price of choice hulled seed.—GERALD MCCARTHY, N. C. Experiment Station.

Advanced Meteorological Summary for the State of North Carolina, November, 1893.

The North Carolina State Weather Service issues the following advanced summary of the weather for November, 1893, as compared with the corresponding month of previous years:

TEMPERATURE.—The mean temperature was 48.3 degrees, which is 1.4 deg. below the normal. The highest monthly mean was 55.8 degrees at Hatteras; the lowest monthly mean was 40.8 at Highlands. The highest temperature was 79 on the 3d at Chapel Hill; the lowest 8 on the 25th at Highlands. The warmest November during the past twenty-two years was in 1881, mean 52.8 degrees; the coldest in 1872, mean 44.1.

PRECIPITATION. — Average for the month 2.64 inches, which is 0.86 inch below the normal. The greatest monthly total was 8.32 inches at Hatteras; least 1.11 at Mocksville. The first light flurries of snow occurred in the western portion of the State on the 14th, in the eastern on the 21st and 24th. The greatest amount of unmelted snow at any station was 1.5 inches on the 24th at Willeyton.

WIND.—Prevailing direction northeast. which is the normal direction. Average hourly velocity 9.2 miles. Highest velocity 58 miles from the northeast at Kitty Hawk on the 8th.

MISCELLANEOUS. — There were 13 clear, 7 partly cloudy, 10 cloudy, and 7 rainy days. Snows occurred on the 11, 14, 15, 17, 21, and 24th. Hail or sleet on the 14, 17, 20, 21, 24, 26 and 27th. Halos were observed on the 3, 4, 13, 18, 20, 21, 22, 33; 25, and 27th, An aurora was observed at Currituck Inlet on the night of the 2d. One severe cold wave prevailed over the State 24th to 26th.

Look for the Pea and Grain Weevils.

During the winter in warm warehouses and in early spring in barns and open granaries thousands of dollars worth of damage is yearly done by seed weevils which bore into the seeds and eat out the interior. Cow Peas and Soy Beans are especially attacked. No time should be lost in destroying these pests which is very easily and cheaply accomplished by the use of Carbon bisulphide. Place the seeds or grain in a tight bin, box, barrel or hogshead or if the room can be closed nearly air tight pile it in a conical heap on the floor. For each 100 pounds of seed allow one ounce of Carbon bi-sulphide. Pour this into a cup and sink the cup to the rim at the top of the heap. Now cover the heap with an old carpet or thick cloth of any kind to

keep in the fumes. If the room is not very large and can be made quite tight no covering of the heap will be necessary but 1-4 to 1-2 more Carbon bi-sulphide must be used. Keep the cloth on or the room closed for twenty-four hours, then expose freely to the air and all traces of the Carbon bisulphide will quickly disappear. The edible quality of the grain or its ability to sprout will be in nowise injured by the treatment, Carbon bi-sulphide readily explodes in presence of fire and no fire or light must be brought into the room as long as the peculiar odor of the Carbon bi-sulphide can be smelled.

Carbon bi-sulphide costs in 6 pound bottles about 20 cents per pound and may be bought of most druggists.—Gerald McCarthy, N. C. Experiment Station.

Culture of Asparagus.

There is no one matter in gardening in which an amateur more commonly fails than in setting an asparagus bed, unless it be in his attempts to grow mushrooms—while both are perfectly easy, when done properly. While an asparagus root in the dormant condition can hardly be killed by cold, wet or drought, my experience is that there is no plant gotten from nurseries that is more commonly injured in transportation by careless packing. When once the roots are heated in a close package, they are worthless for planting. I once lost a shipment of 30,000 Conover's Colossal roots, when they were worth $10 per 1,000, through the reckless packing of them en masse in large tierces. If asparagus roots are to be bought from a nursery, always buy from some one who has a reputation to sustain for careful packing, and get them as close to home as possible. But the most perfect roots are often lost by inexperienced people in planting. They have read that asparagus roots must be set deep in the ground, and thereupon deep down in the ground they bury their yearling roots, and are astonished to see that only here and there a feeble shoot ever reaches sunlight. In my boyhood, the planting of an asparagus bed was one of the grand mysteries of the old negro gardener. He excavated the soil as carefully as an old Scotchman would in planting a grapery under glass, and always paved the bottom with brick-bats, stone or oyster shells. Why he did so no one ever knew, but, "dat's de way to grow sparrergrass;" and he grew it too, for his excavated bed was filled with the lightest and richest of compost, and the paved bottom never hindered the shoots from growing upwards. But with the development of the great market gardening interests in various parts of the country, came more economical and business-like methods. For many years all markets demanded blanched asparagus, and many places still do, while other places want green and tender shoots. The toughness of the blanched shoots has led buyers in many markets of late years to seek green asparagus, and we will give our mode of growing both the blanched and green. The gardener must, of course, grow to suit his market. If it demands white asparagus, he must grow it white, of course, and we would note that asparagus that is all white to the tip is more tender than that which has made a green tip and is only white below, while none is so tender as that which is entirely green.

When asparagus is to be grown in quantity, it is always better to start with the seed rather than to buy the ordinary nursery-grown roots. When well grown, one year old roots are to be preferred to older ones, but the actual nursery-grown roots are so thickly crowded that most people plant two year old roots. I prefer to sow the seed thinly on very rich soil and give careful culture for one season. Such roots are worth double what crowded two year old roots of the nursery are for any mode of subsequent planting. The preparation of the land for asparagus is a most important matter, for the plantation is to last many years and no subsequent manuring or culture can fully atone for deficient preparation. As to varieties, my experience is that one is as good as another. Fine asparagus is wholly a matter of rich feeding. I can take seed from the wild asparagus and grow as fat stalks as from any named seed. Asparagus being a dicœcious plant, and being grown entirely from seed, a purely distinct variety is usually imaginary. The land for an asparagus plantation should be light and warm, for earliness is of prime importance. Above all it should be deep and rich. No ordinary farm land can at once be put in condition to grow the best asparagus, no matter how we may fertilize it. Therefore I prefer to use land that has been for years cultivated and manured for market garden purposes, and which has been thoroughly and deeply worked. Having such a soil and plenty of old, rotten manure we may proceed to plant for blanched asparagus as follows: Run out deep furrows in the well prepared land, five feet apart, by going several times in this furrow and then cleaning out with a shovel. This must be done as early as possible in Spring, or, in this latitude late Autumn. Put a liberal dressing of fine compost in these trenches and work it in with a bull tongue or a one-horse subsoiler.

Now set the roots, spreading them

out in their natural position. Draw in just enough fine soil to cover the crowns an inch or so, and tramp or roll tight with a broad-tired wheel. When the shoots grow, gradually work the soil into the trenches until finally the soil is level. We prefer to cultivate no crops at all between the rows. We should have said that two feet should be allowed between plants in the row. Cultivate clean all the season and flat. Clean off the dead tips at end of season, and at no stage of growth allow any seed-bearing plants to mature seed. This not only weakens the plant, but will give trouble from seedling plants. The second season cultivate as the first season, having given a heavy manuring broadcast, or in the absence of manure, not less than 1000 to 1500 pounds of high grade ammoniated fertilizer. The followin Autumn give a dressing of half a ton per acre of kainit, and manure again in late Winter or early Spring. As this season cutting will begin, the first culture, before any growth begins, should consist in plowing the land in sharp ridges over the rows and cleaning out the dead furrows between so as to drain all water away. These ridges warm up more quickly than the flat land and cause earlier growth. The cutting should be done as soon as the shoots crack the ground, by running a long asparagus knife down near the crown of the root and cutting without hurting the adjacent shoots, cutting none that cannot be long enough for the regular bunching machine. The French growers pull the soil away by hand and pull the shoots without cutting, and then return the soil.

To grow green asparagus, we do not plant in deep trenches, and we can produce asparagus at an earlier date in the season because the roots are nearer the surface. Our practice is as follows: We sow the seed thickly, preferably in Autumn. The land being well prepared, lines are marked out on the level surface, and the young plants are transplanted with a dibble, as soon as they are about as long as one's finger. These young plants can be set very rapidly and they live and grow off as readily as any other Spring plants. We set them rather closer in the row than when planting roots in trenches, say 18 to 20 inches apart. Cultivation is perfectly flat. I once had asparagus fit to cut the next season by this method, but it is better to defer any cutting until the second year, and this will be a year ahead of roots set in trenches. These roots all ramify near the surface and start very early in Spring. The cutting, too, is more simple, because the entire growth, or nearly all, is above ground, only a slight ridge being made in Spring over the rows. The stalks are cut off just below the surface. To my taste, this is by far the best asparagus, and wherever buyers get accustomed to it they no longer want the blanched article. The planting of such a bed is a matter of far less cost than the old method. Of course, the bunching is always done by a machine, making uniform bunches, and it is unnecessary to describe it here. But many growers injure the sale of their asparagus by using poor ties of twine or old rags. Always use flat ties of bass bark or Raffia, and always put two ties on a bunch. Cut the butts square and pack in crates just deep enough to stand the bunches on a bed of fresh moss or grass.—W. F. MASSEY, N. C. Agricultural Experiment Station.

QUESTIONS AND REPLIES.

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Use of Lime and Salt in the Compost.

Will you please write me if it will pay to sprinkle copperas in the compost heap, where only dirt and leaves are used; also will commercial saltpetre grow cotton, potatoes and vegetables better than guano, and what quantity per acre is required?—J. W. H., Wilton, N. C.

(Answered by H. B. Battle, Director N. C. Experiment Station.)

Copperas will have but little effect in decomposing the compost material. In the place of this I would suggest the use of salt and lime in the proportion of one bushel of salt dissolved in small quantity of water added to six bushels of lime to slake it. After the lime is slaked in this way, one bushel of slaked lime can be used with good effect to decompose twenty bushels of rough compost material. Of course smaller quantities can be taken.

Commercial saltpetre contains only nitrogen and no phosphoric acid or potash, hence it is an incomplete application. To give its best effect it should be added to acid phosphate and kainit. The use of the complete fertilizer would be preferable to the saltpetre for a general application. For potatoes and vegetables it can well be added to the usual application of fertilizer.

Hand Separators and Darying.

What is your experience with hand separ-

tors? Will they do what is claimed for them? Name some reliable merchant who would handle butter put up in pound prints to make it net to producer 25 or 30 cents per pound. Butter to be guaranteed of good quality.—W. M. D., Statesville, N. C.

(Answered by F. E. Emery, Agriculturist N. C. Experiment Station.

Yes, the hand separators will do all that is claimed for them when in judicious hands.

In order to check the separator and detect leaks, the Babcock Test should be frequently used. This test will find losses of butter in buttermilk if churning is not thoroughly done. Its prime use however, is to discriminate between good and poor cows and warn against using the profit from one class to support the other. The leading grocerymen of this, and doubtless other cities of this state, buy Northern butter in considerable quantities but will no doubt take all they can get of home make provided it comes at the price Northern factory butter or more for better quality.

We can not name a particular dealer whom we know will take butter at the price named but you will do well to try those nearest you and save expense in freight if possible. If you could undertake dairying on the cooperative plan it would be desirable.

Cheese can be made in hot weather when sales of butter are slow and you would have some other advantages worth considering.

The Peach Borer.

Is the use of paper tied around the base of a peach tree a proper remedy for the borer?—W. M., Speight's Bridge, N. C.

(Answered by Gerald McCarthy, Entomologist N. C. Experiment Station.

Tarred paper tightly bound about the base of trunk with the lower edge banked up with soil is a good preventive as long as the paper is tight enouugh to keep out the moth which lays the eggs from which the borer hatches. The use of tarred paper is specified because the odor of tar is disagreeable to the moth and will drive her away. The use of ordinary wrapping paper is not of much value as it is next to impossible to make a joint close enough between tree and paper to keep out the moth. Tarred paper as above described is a good thing to prevent mice and hares from gnawing the bark of trees during winter.

Cooling Milk.

What is the best and cheapest way of keeping milk cool in summer?—W. B. McL., Ansonville, N. C.

(Answered by F. E. Emery, Agriculturist N. C. Experiment Station.

Where you can use spring water there is no cheaper way than to construct a tank, or even a large wooden trough (cement one is best) through which you can carry the water from the spring. This tank should be 18 or 20 inches deep and its lateral dimensions made to correspond with the size of dairy and methods used, whether deep or shallow, setting in earthen ware or tin. If you have as many as ten or more good cows you should use a separator, and then have only the cream to cool. This will ripen in spring water about as fast as you accumulate enough for a churning. If you are not too far from the railroad to ship to the Charlotte Creamery it would probably pay best to run a separator to skim the milk for six or eight to a dozen farms and ship cream to the factory.

Turnips—Keeping Pork—Pecans.

Is there more nutriment in the Southern Prize turnip than the yellow Ruta Baga? Will the Ruta Baga alone fatten hogs for pork, or should they be boiled with fine Indian meal for that purpose? What is the best way for keeping pork and bacon sweet and good for twelve months? Is there more profit in a chinquapin orchard than pecans?—W. T. P., Trenton, N. C.

(Answered by W. F. Massey. Horticulturist N. C. Experiment Station.)

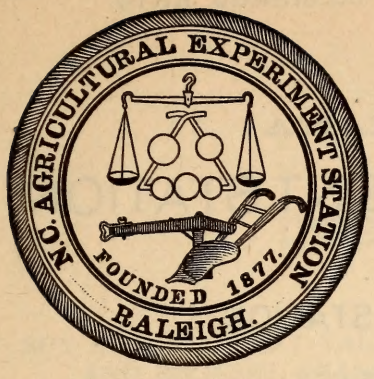
In the absence of any analysis that I can find, I must say that I think the yellow Ruta Baga more nutritive than any white turnip, but if you depend upon either of them to fatten pork you will have lean meat and not much of it. Sweet patatoes are worth far more for hog feeding than turnips. With sweet potatoes and a good pea field you can make good pork cheaply.

My mode of curing hams is to make a good brine, strong enough to float a potato; boil and skim it of impurities, and when cold stir in one pint of black molasses for every 100 pounds of meat and 1-2 ounce of saltpetre to same amount. Have brine enough to entirely cover the meat. Hams and shoulders should stay in the pickle from four to six weeks. Then hang up in smoke house and drain. When drained, smoke well with hickory wood, corn cobs and green cedar brush (no pine). After smoking rub them well all over with molasses made thick with black pepper, sew them up in cotton bags, or pack them down in dry oat chaff. A ham is not in its best condition until a year old. Similar treatment will do for other parts, but thin pieces need not remain in brine so long.

Never cultivate chinquapins. Demand is too light for them to make them pay, and the nuts do not keep long. People who want to sell pecan trees are now figuring tremendously on the profits. It is all very well to have a few pecan trees for home use, but the fortunes some people are expecting out of pecans, we would not like to discount now at 90 per cent. off.

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January 30, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 97.

DIGESTION EXPERIMENTS

WITH

SOY-BEAN HAY, CAT-TAIL MILLET, JOHNSON GRASS HAY, SORGHUM FODDER AND BAGASSE, PEANUT-VINE HAY, COTTON-SEED MEAL, COTTON-SEED HULLS, CRIMSON CLOVER HAY, CORN MEAL, CORN-AND-COB MEAL, AND CORN SILAGE.

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RALEIGH, N. C.

DIGESTION EXPERIMENTS

WITH

SOY BEAN HAY, CAT-TAIL MILLET, JOHNSON GRASS HAY, SORGHUM FODDER AND BAGASSE, PEANUT-VINE HAY, COTTON-SEED MEAL, COTTON-SEED HULLS, CRIMSON CLOVER HAY, CORN MEAL, CORN-AND-COB MEAL, AND CORN SILAGE.

By F. E. EMERY, Agriculturist, and B. W. KILGORE, Assistant Chemist.

The value of foods depends very largely upon their composition and digestibility; the former is ascertained by chemical analysis, the latter by actual feeding trials with animals. In this bulletin are presented the results of the past year's study of the value of the cattle foods of the State. Most of the experiments were made in connection with regular feeding experiments for the production of beef and milk, the results of which are presented in another bulletin.

The Digestibility of Foods and Digestion Experiments.

A food in passing through the alimentary canal is acted upon by the alimentary agents, saliva, gastric juice, bile, pancreatic juice, and the secretions of the small and large intestines, and partly dissolved or otherwise changed so as to be capable of absorption and assimilation. This portion of a food which is thus taken into the circulation of the system is said to be *digested and is the only part of a food of any direct value in the nourishment of the animal body.* The residue, or undigested portion, passes from the body unused and forms the solid excrement.

Since only the digestible or soluble portion of a food is of any nutritive value to the animal, it is of the utmost importance, in a rational and economical system of feeding, that we should know the portions of the nutrients, protein, fats, etc., (the total amounts being shown by analysis) that are actually digested. This is determined by feeding trials with animals and are known as *digestion experiments.* A digestion experiment requires a great deal of very careful experimental work, and in brief is carried out by feeding an animal a uniform and weighed quantity of food of known composition for sufficient length of time to eliminate all residues of previously fed foods, then collecting the solid excrement for a number of days, usually five or six, weighing and analyzing it. The solid excrement

Mr. R. E. Noble, formerly Assistant Chemist of the Station, assisted in making the analyses and in working up the results of these experiments.

contains the undigested food-residue, and the difference between this and the total food consumed gives the portion digested. The results presented in this bulletin are precisely this answer obtained by animals from a number of ordinary foods and rations. Thus two foods of the same or different composition would be valued according to the amounts of digestible nutrients each contained. It is hoped that this and past bulletins of the Station on this subject will be of material benefit to the farmers of the State in giving them a better knowledge of the foods they have to deal with.

Terms Defined.

By chemical analysis, foods are separated into six classes of substances, viz:

1. *Water*, which is present in all feeding stuffs. It composes about 80 per cent. of green and succulent fodders, about 90 per cent. of root crops, 75 per cent. of silage, and 10 to 15 per cent. of hays and grains. In these it is present as mechanically adhering or hygroscopic moisture. It is a necessary constituent of the animal body, of which it makes up 40 to 65 per cent. Water is determined by heating the substance for several hours at the temperature of boiling water, at which temperature it passes off as steam.

2. *Ash* is the inorganic, or mineral matter, of plants, and is the residue left after burning till all volatile material is driven off. It is composed mainly of soda, potash, lime, and magnesia, in the form of phosphates, sulphates, chlorides, and carbonates. Ash furnishes the materials for the bony structure of animals, and enters to a much less extent into the tissues and organs.

3. *Fats* (*Ether extract*) represents whatever is dissolved from foods by dry ether. It is composed mainly of fats and oils, but contains, in addition, quantities of gums, wax and coloring matter, depending upon the substances extracted.

4. *Protein*, the term as used in connection with fodder analyses, includes *Albuminoids* and *Amides*, the albuminoids being the more valuable, and, at the same time, composing by far the larger portion of the protein compounds. They are the nitrogenous compounds of plants and animals, and are determined by estimating the nitrogen in them, which element composes about 16 per cent. of the weight of protein substances. None of the other classes of substances contain nitrogen. They are represented in the animal body by ligaments, lean meat, muscles, tendons, and tissues.

5. *Crude fiber*, or *cellulose*, is the cell wall and structure material of plants, and is usually the most indigestible portion of them, but when digested is considered of equal value to starch and sugar. The lint of cotton is almost pure cellulose. Its composition is similar to that of starch. It is determined by boiling the food-stuff with weak acid and alkali, thus dissolving all other constituents. *Crude fiber* and *nitrogen-free extract* taken together are known as *carbohydrates*.

6. *Nitrogen-free extract* is the term applied to those non-nitrogenous constituents of foods which are represented in the main by sugars, starch, dextrin, and gums. They all contain carbon, hydrogen, and oxygen, but no nitrogen, as does protein. Nitrogen-free extract is estimated by difference, it being equal to the difference between the sum of the above five constituents, water, ash, protein, fats, and crude fiber, and 100.

Dry matter represents all the substances in foods except water, and is what is left after the water is driven off or subtracted.

Coefficients of digestibility are the per cents. of the different nutrients digested, and are obtained by dividing the total amount of each nutrient consumed by the animal into the amount digested.

The nutritive ratio of a food is the ratio of the digestible protein to the sum of digestible carbohydrates and fats, the fats being previously multiplied by 2 5.*

Nutrients.—Protein, fats, carbohydrates, nitrogen-free extract and crude fiber, and mineral matter are called nutrients, because of their functions in animal nutrition. Nigrogen-free extract and crude fiber are included together under the one name of carbohydrates, because they are all compounds of carbon, hydrogen, and oxygen, and the digestible portion of each is considered of equal value and perform the same offices in animal nutrition.

Functions of nutrients.—Having defined the classes of nutrients as they occur in foods, it is now in order to state the offices performed by them in animal nutrition.

Water is not a nutrient in the sense in which the term is here used, though the animal body cannot be supported without it.

The ash, or mineral matter, furnishes the material for the bony structure of the body, and, to a far less extent, of the soft tissues. Most of our foods and rations contain an abundant supply of the mineral elements, so little or no notice need be taken of them in feeding.

Protein differs from all the other nutrients in containing the element nitrogen, and is the producer of flesh, ligaments, muscles, tendons, sinews, hair, hide, and all portions of the animal machine which has strength, except the bones. The protein bodies are of the utmost importance in the animal structure. They compose the larger part of the animal machinery, and are the exclusive source of its repair as occasioned by the continuous wear and tear of the system, due to the internal and external movements of the body; they are the basis of blood, and the source of casein in milk; and in the absence of sufficient quantities of fats and carbohydrates in the food for the production of heat and energy, they are transformed

*Experimenters and feeders now generally use factors varying from 2.2 to 2.27 for bringing fats to the same nutritive basis as carbodydrates, and we agree with them that these factors are more nearly correct than 2 5, but we adhere to the latter in order that our ratios may be comparable with those in the German standard.

into fats, and perform the office of fats in nutrition. This latter transformation may also result from an excess of protein. The heat-producing power of protein is but little different from that of carbohydrates; the amount of fat it produces is probably much less, while, as a heat-producer, fat is worth about 2.25 times as much as protein. These facts, combined with the high cost of protein in foods, renders it usually uneconomical to feed protein for the production of fat to be either stored in the body as such, or to be used as fuel, since the fats and carbohydrates perform these offices, and cost much less. It is to remembered that the protein bodies are the "flesh formers," and though they can perform the offices of fats and carbohydrates in nutrition, fats and carbohydrates cannot take the place of protein.

Fats and carbohydrates perform the same offices in the body—those of the production of heat to keep the body warm, and the force by which the animal mechanism is run. They are the "heat and force producers," and are consumed in the body as fuel, giving out heat, muscular, and intellectual energy. For the production of heat and energy one pound of fat is worth about 2.25 times as much as a pound of carbohydrates. Fats give out about 2.25 times the heat that carbohydrates do. Besides serving as heat and force producers, carbohydrates are converted in the animal body into fats, and, together with the fats of the food, are stored as such in fatty tissue. The value of carbohydrates for the production of fats is supposed to be in about the same proportion as the heat-producing powers of carbohydrates to fats.

The main and distinctive offices of the nutrients of foods are: Ash, or mineral constituents, are bone-producers; the protein bodies are the flesh-formers; and fats and carbohydrates are the heat and force producers. The nutrients already located in the animal body perform the same offices as the corresponding ones of foods.

Different Rations Experimented With.

In Technical Bulletins Nos. 3 and 4 (Bulletins 80c and 87d) were presented the results of the previous two years' work on determining the digestibility and value of certain feeding stuffs. The present bulletin contains the results of the past and third season's investigations in the same line, and includes digestion experiments and deductions therefrom, upon:

1. Soy (soja) bean hay, with two animals.
2. Cat-tail millet, with one animal (in duplicate).
3. Johnson grass hay, with one animal.
4. Sorghum fodder (pulled leaves alone), with two animals.
5. Peanut-vine hay, with two animals.
6. Sorghum bagasse, with one animal.
7. Sorghum bagasse and cotton-seed meal (ratio 1.86 to 1 eaten), with one animal.
8. Crimson clover hay (one-year old), with two animals.

9. Crimson clover hay and cotton-seed meal (ratios 6.4 to 1 and 3.09 to 1 eaten), with two animals.

10. Crimson clover hay and cotton-seed meal (ratios 3.5 to 1 and 3 53 to 1 eaten), with one animal (in duplicate).

11. Cotton-seed hulls and cotton-seed meal (ratios 3 to 1 and 2.8 to 1), two animals.

12. Cotton-seed hulls and cotton-seed meal (ratios 2.4 to 1, 2.02 to 1, and 2 to 1, eaten), with two animals, three experiments.

13. Digestibility of corn silage alone and in ration with cotton-seed meal.

14. Corn meal, with one animal.

15. Corn meal and crimson clover hay (1 to 1.83 and 1 to 2.36 eaten), with two animals.

16. Corn-and-cob meal, with one animal.

17. Crimson clover hay and corn-and cob meal (ratios 1 to 1.8 and 1 to 1.35 eaten), with two animals.

18. Composition of foods used in the experiments (see page 93).

19. Summary of coefficients of digestibility (see page 94).

The Animals Employed.

The same two goats used for the digestion work last reported* have been used during this winter's feeding. The spotted grade Jersey heifer (called "Spot"), now a promising young cow, has also been used with the goats, together with a native heifer ("Miss Haley") of about the same age for the digestion of crimson clover hay alone and rations with it. "Spot," the grade Jersey, was also fed in the digestion of sorghum fodder and soy bean hay. These heifers brought their first calves in September and October, previous to beginning the digestions in January, 1893. For a continuance of the digestion of rations of cotton-seed hulls and meal, a pair of large old steers was purchased. These when fat were turned off to the butcher, when the work was completed.

Summary of Results.

1. *Soy (soja) bean hay.*—Last year the digestibility of soy bean silage was reported. To complete our study of this plant, the digestibility of the hay was made. There is very little difference in the results of the two investigations, showing both the silage and the hay to be most valuable and highly nitrogenous fodders. As the soy bean is a leguminous, or nitrogen gathering plant, it is hoped that its cultivation and use will greatly increase.

2. *Cat-tail millet.*—The composition, digestibility, and nutritive ratio of cat-tail millet show it to be of itself a good food, and indicate that it can be fed alone with profit. This, coupled with the yield, speaks well for it.

*Bulletin No. 87d, Technical Bulletin No. 4.

3. *Johnson grass hay* is a coarse carbonaceous food with a wide nutritive ratio. It yields heavily, however, and where it can be grown without being troublesome in the cultivation of clean crops, will furnish large quantities of coarse fodder to feed with such nitrogenous foods as cotton-seed meal. The sample submitted to digestion in this experiment was rather a poor one, and the coefficients are probably somewhat lower than they would be for a first-grade hay.

4. *The sorghum fodder* (leaves alone) fed in this experiment was pulled at the time the sorghum was being stripped for grinding. Its composition, digestibility, and nutritive ratio show it to be about the same in feeding value as ordinary corn blades, though the yield of sorghum fodder is much greater per acre. As to whether it will pay to harvest sorghum fodder for feed, will depend very much upon circumstances.

5. *Peanut-vine hay* consists of the top of the plant after the kernels are removed, and resembles corn leaves in composition and digestibility, though is a somewhat more valuable food on account of the larger amount of digestible protein and narrower nutritive ratio. It could be fed alone with fair profit for slow gains. The peanut plant is a nitrogen gatherer and the tops are a good hay.

6. *Sorghum bagasse* is the residue of the stripped sorghum canes after grinding. The sample submitted to digestion was cut into short lengths with a silage cutter. It resembles cotton-seed hulls in composition; is materially more digestible than hulls, but not so readily eaten. When fed fresh, before it dries out, or is preserved in a silo, it is eaten with considerable relish. Our experience with it leads us to believe that it is a waste by-product that can be used to advantage by some.

7. *Ration of sorghum bagasse and cotton seed meal, 1.86 to 1.*—To further test the value of sorghum bagasse, it was fed in ration with cotton-seed meal in proportion of 4 to 1, but eaten in the proportion of 1.86 to 1. This ration was eaten well and was digested considerably better than a similar one of cotton-seed hulls and meal having practically the same nutritive ratio. This result, combined with that of the previous experiment on bagasse alone, indicate sorghum bagasse to be a better coarse food than cotton-seed hulls, and we considered it should be saved and utilized where a very coarse fodder can be used to advantage.

8. *One-year-old crimson clover hay.*—The digestibility of a portion of this same lot of hay was determined when new and reported last year. Its digestibility was re-determined a year later to see if it had changed in composition and digestibility and to be used in other experiments. The old hay had suffered a loss of 1 per cent. in nitrogen compounds and slight changes in other constituents, but there was very little difference in the digestibility of the two hays beyond a small decrease in the digestibility of the fats and nitrogen-free extract of the old hay.

9–10. *Rations of crimson clover hay and cotton-seed meal.*—The diges-

tibility of four rations of crimson clover hay and cotton-seed meal were determined, viz.: 6.4 to 1, 3.53 to 1, 3.5 to 1, and 3.09 to 1. They were all digested well and make good showings for the rations, but they are too heavy for ordinary feeding. Their digestibility were determined to arrive at the digestibility of cotton-seed meal, which could not be fed alone, and the results obtained for this latter material confirm our high opinion of it as being our most valuable concentrated food.

11. *Rations of cotton-seed hulls and meal, 3 to 1 and 2 8 to 1.*—These rations contain quite a large proportion of cotton seed meal in comparison with what has usually been fed. The nutritive ratios of the rations as digested show them however to be about the same in the proportion of food constituents actually digested as are required by the German standard for fattening. These rations were well eaten and gave good results in fattening steers in our stables.

12. *Rations of cotton-seed hulls and meal, 2 to 1.*—This ration is still more concentrated and narrow in nutritive ratio than either of the preceding. In fact, the nutritive ratio of this ration is narrower than is called for by the German standard for any of the periods of fattening, yet it was readily eaten and gave good results in our feeding trials for beef.

13. *Digestibility of corn silage alone and in rations with cotton-seed meal.*—The digestibility of corn silage was determined by feeding alone and then in rations of 12 to 1, and 8 to 1 with cotton-seed meal. When fed alone 53.2 per cent. of the silage was digested; with cotton-seed meal, 12 to 1, 60.1 per cent.; with cotton-seed meal, 8 to 1, 67.4 per cent. of the silage was digested. These figures indicate that the silage was more digestible in the rations with meal than alone. The nutritive ratios of the rations of 12 and 8 pounds corn silage to 1 pound cotton-seed meal were 1 to 6.29, and 1 to 4.98, and would be good rations for the 1st and 2d periods respectively of fattening.

14. *Corn meal* is a highly digestible food, but the proportion of the food constituents in it alone are not the best for economical results in most kinds of feeding.

15. *Rations of crimson clover hay and corn meal, 2.36 to 1 and 1.83 to 1.*—These rations have a very high rate of digestibility and the proportion of nutrients in them are good, far better than in corn meal alone, and would be good rations for milk, for first period of fattening of steers, or for horses or oxen at work.

16. *Corn-and-cob meal* does not have so high coefficients of digestibility as corn meal but the proportion of food constituents in the two are not very different, and the remarks about corn meal apply also to corn-and-cob meal. According to our experiments and calculations 12.96 per cent. of the total digestible dry matter in ear corn was saved by feeding the ground cobs with the meal.

17. *Rations of crimson clover hay and corn-and-cob meal, 1.8 to 1, and 1.35 to 1.*—These rations have quite a high rate of digestibility, and

the proportion of the food constituents in the ration of 1.8 pounds hay to 1 pound corn-and-cob meal are such as to recommend the ration for the same purposes as given for the rations of crimson clover hay and corn meal in paragraph 15. The nutritive ratio of the ration of 1.35 pounds hay to 1 pound meal is rather wide for most feeding purposes.

18. *Composition of foods and coefficients of digestibility.*—To facilitate examination and comparison the composition of all the foods used in the experiments and a summary of the coefficients of digestibility of all the foods and rations with nutritive ratios are brought together in tables A and B, (pages 95 and 96). The composition of the foods is shown on basis of air-dry material as they are fed and is the basis to be used in calculating rations from like foods on hand. In addition to the composition of the foods obtained by analysis, is presented, also, the percentage of digestible nutrients in each, calculated from the percentage composition of the foods in the table by multiplying by the coefficients of digestibility of each food and nutrient. These per cents. represent so many pounds of digestible nutrients in 100 pounds of the air-dry hay or food, and are in convenient shape to be used in making rations from these foods.

TABLE A.—Showing Composition of Foods Used in Experiments.

Foods.	Parts in 100 of air-dry substance							Per cent. of digestible matter					
	Water.	Dry matter.	Ash.	Protein.	Fats. (Ether extract)	N-free extract.	Crude fiber.	Dry matter.	Ash.	Protein.	Fats.	N-free extract.	Crude fiber.
Soy (soja) bean hay	17.38	82.62	6.35	15.53	2.66	32.52	25.55	51.52	1.50	11.04	.78	22.38	15.54
Cat-tail millet	11.04	88.96	8.10	11.56	2.28	40.20	26.82	55.42	5.54	7.23	1.05	23.77	17.84
Johnson grass hay	12.31	87.69	5.15	5.77	1.67	44.80	30.30	47.81	2.89	2.58	.66	24.36	17.52
Sorghum fodder (leaves alone)	12.43	87.57	4.56	9.60	4.55	44.93	23.93	55.25	1.34	5.84	2.12	28.99	16.84
Peanut-vine hay	10.44	89.56	6.80	10.31	3.57	42.92	25.96	53.60	1.39	6.53	2.35	29.83	13.47
Sorghum bagasse	11.25	88.75	2.88	3.44	1.44	50.47	30.52	53.78	.38	.47	.67	32.72	19.46
Cotton-seed meal	7.03	92.97	5.76	39.35	11.84	29.54	6.48	68.15	1.81	34.55	10.62	18.17	3.01
Crimson clover hay	11.46	88.54	6.27	15.04	2.01	38.49	26.73	54.11	3.73	10.26	.87	25.62	13.74
Cotton-seed hulls	12.35	87.65	1.65	4.22	2.74	35.56	43.48	36.02	.35	.25	2.18	12.20	20.61
Corn meal	12.68	87.32	1.32	8.81	4.39	71.25	1.55	75.87	.....	5.89	3.53	63.13	.....
Corn-and-cob meal	12.43	87.57	1.24	7.90	3.33	67.10	8.00	68.94	.....	5.15	2.82	57.44	3.82
Cow pea vine hay*	11.90	88.10	8.42	14.43	2.49	41.22	21.54	52.15	3.79	9.31	1.24	29.14	9.24
Lucerne, or alfalfa hay*	11.53	88.47	6.90	14.89	2.24	34.18	30.26	52.55	.....	10.85	1.15	23.21	13.95
Red clover hay*	11.63	88.37	6.15	12.50	2.43	40.43	26.81	45.69	.....	6.17	1.03	23.28	12.73
Corn fodder, whole plant*	32.19	67.81	4.32	4.81	1.28	37.15	20.21	.....	.....	2.60	.90	23.63	13.84
Timothy hay*	10.21	89.79	4.22	6.18	2.19	46.91	30.29	51.90	1.46	3.03	1.21	30.16	16.14
Red top hay*	9.52	90.48	5.93	7.70	2.14	46.19	28.52	52.12	1.44	4.65	.94	27.30	17.45
Orchard grass hay*	9.80	90.20	5.63	6.82	2.38	42.12	33.23	51.68	1.95	4.08	1.29	23.42	20.40
Mixed hays*	15.41	84.59	4.73	6.25	2.09	40.30	31.21	45.93	.....	2.99	1.04	22.93	14.95

*These are inserted for comparison with the materials experimented upon, and are each the average results obtained upon quite a number of samples.

TABLE B.—Summary of Coefficients of Digestibility and Nutritive Ratios.

Foods.	No determinations.	Dry matter.	Ash.	Protein.	Albuminoids.	Fats. (Ether extract)	Nitrogen-free extract.	Crude fiber.	Nutritive ratio, 1:
Soy (soja) bean hay	2	62.36	23.70	71.08	54.18	29.22	68.81	60.84	3.55
Cat-tail millet	2	62.30	68.40	62.57	41.49	46.10	59.13	66.51	6.15
Sorghum fodder (leaves alone)	2	63.09	29.47	60.83	45.14	46.69	64.53	70.38	8.94
Johnson grass hay	1	54 52	56.10	44.71	39.58	39.48	54.37	57.83	14.22
Peanut-vine hay	2	59.85	20.44	63.31	52.95	65.94	69.50	51.90	7.69
Sorghum bagasse	1	60.60	13.35	13.65	2.59	46.42	64.84	63.75	120.8
Ration sorghum bagasse and cotton-seed meal, 1.86 to 1	1	62.18	7.10	77.77	77.27	84.54	62 54	54.14	4.19
Crimson clover hay (one-year old)	2	61.11	59.42	68.23	61.14	43.23	66.55	51.40	4.47
Ration crimson clover hay and cotton-seed meal, 6.4 to 1	1	61.90	54.31	74.17	69.75	67.98	64.13	51.24	3.23
Ration crimson clover hay and cotton-seed meal, 3.5 to 1	2	63.41	54.08	74.77	71.62	71.15	66.36	49.35	2.81
Ration crimson clover hay and cot ton-seed meal, 3.09 to 1	1	66.91	54.28	81.31	78.94	75.43	67.45	55.00	2.68
Cotton-seed meal in above rations	4	73.3	31.5	87.8	87.1	89.7	61.5	46.4	1.38
Ration cotton-seed hulls and meal, 3 to 1	1	54.95	28.87	60.98	60.50	86.96	55.31	49.63	5.89
Ration cotton-seed hulls and meal, 2.8 to 1	1	51.54	33.01	62.33	61.82	84.20	51.76	43 55	5.13
Ration cotton-seed hulls and meal, 2.4 to 1	1	52.04	30.27	61.55	61.09	83.68	53.55	43.12	4.88
Ration cotton-seed hulls and meal, 2 to 1	2	53.55	26.84	64.67	64.19	82.26	49.47	49.53	4.27
Corn meal	1	86.89	....	66.89	66.89	80.47	94.22	....	14.02
Ration corn meal and crimson clover hay, 1 to 2.36	1	68.69	41.81	62 33	56.32	68.21	81.26	47.17	6.77
Ration corn meal and crimson clover hay, 1 to 1.83	1	73.60	62.11	70.55	65.73	72.41	83.84	50.93	6.64
Corn-and-cob meal	1	78.73	....	65.21	65.21	84.59	85.61	47.69	13.19
Ration corn-and-cob meal and crimson clover hay, 1 to 1.8	1	65.71	44.72	63.67	59.67	62.17	76.81	44.05	6.58
Ration corn-and-cob meal and crimson clover hay, 1 to 1.35	1	70.37	49.13	59.33	55.39	66.92	80.34	56.81	10.04

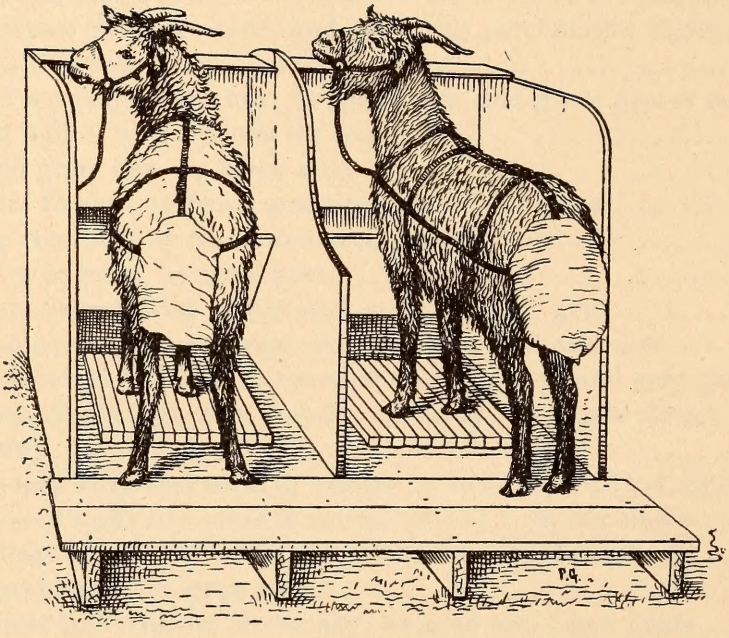
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[The previous pages present a condensed Summary of the several subjects treated in this Bulletin. The detailed account will be found in the following pages (101 to 132). Persons who do not receive these latter pages can be supplied by making application to Dr. H. B. BATTLE, Director, Raleigh, N. C.]



I. DIGESTION OF SOY (SOJA) BEAN HAY,

BY BLACK GOAT, AND GRADE JERSEY COW, "SPOT."

Date of experiment, February and March, 1893.

Daily ration { Black goat, 1200 grams fed.
Spot, 16 pounds.

Total period, 14 days.

Collection period, the last 5 days.

Analytical and other data for obtaining coefficients of digestibility are contained in Tables I and II.

FEEDS.—Previous to the beginning of each experiment, the feeding material or materials were thoroughly mixed in sufficient quantity for the entire experiment, and from this mixture the separate feeds for the whole period were weighed out, thus obviating any error from change of moisture. Samples for analysis were also taken from the above mixture.

WASTE.—The total wastes were in all cases saved and sampled for analysis at the end of the experiment.

The soy beans for this experiment were grown after an early crop and were cut in September, when a portion was in bloom, with the most forward part of the crop showing nearly mature seed. One thousand pounds were cut, and stored in the barn loft to cure. This dried to two hundred and seventy-five pounds of hay, losing about 73 per cent. of the green weight.

Neither the cow nor the goat ate enough of this hay to maintain the live weight. The digestion by the two animals was quite uniform. Comparing the coefficients found for this hay with those for soy bean silage, there is a fair degree of correspondence. The dry matter and nitrogenenous compounds gave a rather higher per cent. in the hay, while the nitrogen-free extract and crude fiber of the hay were considerably better digested than were those of the silage. These differences were not wider than those occurring between the coefficients for the same constituents when the animals were fed on silage or hay.

TABLE I.—Showing percentage Composition of Soy Bean Hay, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6 25)	Albumi'ds (Alb. N ×6.25)	Fats (Ether extract)	N-free extract.	Crude fiber.
Soy bean hay	17.38	82.62	7 69	18.80	11.81	3.22	39.36	30 93
Waste, soy bean hay, black goat	11.84	88.16	20.70	18.65	11.37	3.65	30.20	26.80
Waste, soy bean hay, grade Jersey cow, "Spot"	14.89	85.11	7.43	18 56	11.94	1.62	50.82	21.57.
Solid excrement, black goat	52 59	47.41	14.04	14.83	14 83	6.52	32.22	32.39
Solid excrement, grade Jersey cow, "Spot"	80.31	19.69	10.92	14.11	14 11	5.66	33.96	35.35

TABLE II.—Showing Nutrients Consumed and Excreted in Ounces†, with percentages Digested.

BLACK GOAT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds. (Alb. N ×6.25)	Fats. (Ether extract.)	N-free extract.	Crude fiber.
Soy bean hay fed	211.64	174.86	13.45	32.87	20.65	5.63	68.82	54.08
Waste, soy bean hay	55.64	49.05	10.15	9.15	5.58	1.79	14.81	13.14
Total consumed	156.00	125 81	3.30	23.72	15.07	3.84	54.61	40.94
Total solid excrement	100.91	47.84	6.72	7.09	7.09	3.12	15.41	15.50
Total digested	------	77.97	------	16.62	7.98	.72	38.60	25.44
Per cent. digested	------	**61.97**	------	**70.07**	**52.95**	**18.75**	**71.47**	**62.14**

GRADE JERSEY COW, "SPOT."

Soy bean hay fed	1280.0	1057.5	81.32	198.81	124.89	34.05	416.23	327.08
Waste, soy bean hay	183.3	156.0	11.59	28.95	18.63	2.53	79.27	33.65
Total consumed	1096.7	901.5	69.73	169.86	106.26	31.52	336.96	293.43
Total solid excrement	1705.3	335.8	36.67	47.38	47.38	19.01	114.04	118.71
Total digested	------	565.7	33.06	122.48	58.88	12.51	222.92	174.72
Per cent. digested	------	**62.75**	**47.41**	**72.10**	**55.41**	**39.69**	**66.15**	**59.54**
Mean of both animals	------	**62.36**	**23.70**	**71.08**	**54.18**	**29.22**	**68.81**	**60.84**
*Mean coefficients for soy bean silage	------	**59.02**	**56.71**	**75.75**	**66.1**	**71.86**	**52.02**	**54.80**

Mean nutritive ratio of soy bean hay 1:3.55.

*Mean nutritive ratio of soy bean silage 1:4.22.

*Bulletin 87d, Technical Bulletin No. 4, p. 14, N. C. Experiment Station.

†One ounce is equivalent to 28.35 grams.

II. DIGESTION OF CAT-TAIL MILLET,

BY GRAY GOAT.

Date of experiment, January and February, 1893.

Daily ration { First experiment, 900 grams. / Second experiment, 900 grams.

Total period, 23 days.

Collection period, the last 12 days, divided into two periods of 5 and 7 days each.

Analytical and other data for obtaining the coefficients of digestibility are presented in Tables III and IV.

TABLE III.—Showing percentage Composition of Cat-tail Millet, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Cat-tail millet	11.04	88.96	9.10	12.99	8.25	2.56	45.20	30.15
Waste, cat-tail millet, 1st experiment	12.14	87.86	7.02	14 09	8.31	2.47	43.89	32.53
Waste, cat-tail millet, 2d experiment	18 53	81 47	7.02	12.50	8.37	2.55	44.81	33 12
Solid excrement, 1st experiment	53.01	46 99	8.20	12.29	12.29	3.93	50.06	25.52
Solid excrement, 2d experiment	56.21	43.79	7 88	13.23	13.23	3.45	48.50	26.94

TABLE IV.—Showing Nutrients Consumed and Excreted in Grams with percentages Digested.

GRAY GOAT, FIRST EXPERIMENT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6 25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Cat-tail millet fed	4500.0	4003.2	364.29	520.02	330.26	102.48	1809.45	1206.96
Waste, cat-tail millet	1086.0	954.2	66.98	134.45	79.29	23.57	418.80	310.40
Total consumed	3414.0	3049.0	297.31	385.57	250.97	78.91	1390.65	896.56
Total solid excrement	2365.0	1111.3	91.13	136.58	136.58	43.67	556.32	283.60
Total digested	.....	1937.7	206.18	248.99	114.39	35.24	834.33	612.96
Per cent. digested	.....	**63.55**	**69.35**	**64.58**	**45.58**	**44.66**	**60.00**	**68.36**

GRAY GOAT, SECOND EXPERIMENT.

Cat-tail millet fed	6300.0	5604.5	510.01	728.02	462.37	143.48	2533.23	1689.76
Waste, cat-tail millet	937.5	763.8	53.62	95.48	63.93	19.48	342.26	252.97
Total consumed	5362.5	4840.7	456.39	632.54	398.44	124.00	2190.97	1436.79
Total solid excrement	4304.4	1884.9	148.53	249.37	249.37	65.03	914.18	507.79
Total digested	.....	2955.8	307.86	383.17	149.07	58.97	1276.79	929.00
Per cent. digested	.....	**61.06**	**67.45**	**60.57**	**37.41**	**47.55**	**58.27**	**64.66**
Mean of two experiments	.....	**62.30**	**68.40**	**62.57**	**41.49**	**46.10**	**59.13**	**66.51**

Mean nutritive ratio of cat-tail millet 1:6.15.

Cat-tail millet (*Pennisetum spicatum*) is also known as Pearl and Egyptian millet. It was sown after a second crop of red clover had been cut on land which has been raised to a good state of cultivation by use of stable manure on forage crops. The millet was cut from heading out to past bloom as needed to feed, and yielded at the rate of 16,745 pounds per acre. That cut for this experiment was the first when the panicles were just appearing above the leaves. It was cured under cover and was in good condition when used.

The coefficients of digestibility and the nutritive ratio point this out as of great value to feeders of stock who need a good heavy crop of coarse fodder. It is a gross feeder, and stable manure should be applied freely for profitable returns.

III. DIGESTION OF JOHNSON GRASS HAY,

BY BLACK GOAT.

Date of experiment, January and February, 1893.
Daily ration, 3 pounds.
Total period, 14 days.
Collection period, the last 5 days.

TABLE V.—Showing percentage Composition of Johnson Grass Hay, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Johnson grass hay	12.31	87.69	5.87	6.58	6.13	1.90	51.10	34 55
Waste, Johnson grass hay	11.73	88.27	4.58	4.14	4.14	1.34	49.12	40.82
Solid excrement	52.25	47.75	6 22	9.32	9.32	2.86	52.15	29.45

TABLE VI.—Showing Nutrients Consumed and Excreted in Grams with percentages Digested.

BLACK GOAT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Johnson grass hay fed	6804.8	5967.1	350.27	392.64	365.78	113.37	3049.19	2061.63
Waste, Johnson grass hay	2082.0	1837.8	84.17	76.08	76.08	24.63	902.73	750.19
Total consumed	4722.8	4129.3	266.10	316.56	289.70	88.74	2146.46	1311.44
Total solid excrement	3932.5	1877.8	116.80	175.01	175.01	53.70	979.27	553.01
Total digested		2251.5	149.30	141.55	114.69	35.04	1167.19	758.43
Per cent. digested		54.52	56.10	44.71	39.58	39.48	54.37	57.83

Nutritive ratio of Johnson grass hay 1:11.22.

Analytical and other data for obtaining the coefficients of digestibility are presented in Tables V and VI.

The Johnson grass hay used in this experiment was grown on a neighboring farm, and was rather weather beaten, having been wet in a few days of dull weather. It was cut at the stage of panicling to bloom. This is a coarse, rank growing grass, capable of great yields from two or three cuttings in a single season, but common experience puts it under ban as a troublesome weed in cultivated grounds.

The low digestibility and wide nutritive ratio found for this sample is probably partly due to the weathering.

IV. DIGESTION OF SORGHUM FODDER,

BY BLACK GOAT AND GRADE JERSEY COW, "SPOT."

Date of experiment, February, 1893.

Daily ration { Black goat, 1200 grams. / Spot, 18 pounds.

Total period, 13 days.

Collection period, the last 5 days.

Analytical and other data for obtaining the coefficients of digestibility are contained in Tables VII and VIII.

TABLE VII.—Showing percentage Composition of Sorghum Fodder, Waste and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Sorghum fodder	12.43	87.57	5.21	10.96	7.87	5.19	51.31	27.33
Waste, sorghum fodder, black goat	17.51	82.49	8.51	11.29	8.56	4.20	50.80	25.20
Waste, sorghum fodder, grade Jersey cow, "Spot"	17.56	82.44	11.60	13.16	10.50	5.00	50 06	20.18
Solid excrement, black goat	53.80	46.20	9.66	11.02	11.02	7.05	48.04	24.23
Solid excrement, grade Jersey cow, "Spot"	85.08	14.92	8.89	12.25	12.25	8.28	50.94	19.64

The fodder used in this experiment was from varieties grown for syrup, Black African cane, which yielded 1174.5 pounds of cured fodder per acre; and Collier's, 1111.4 pounds per acre. The fodder was stripped in the usual way of pulling corn fodder when the canes were wanted for grinding. The fodder had a good effect on the animals, and though the cow fell off one and a-half pounds in yield of milk per day from the last six days of the previous period to the last six on sorghum fodder, this is not a very great decrease when comparison of rations is made. Milk was produced at very nearly

the same cost from 18 pounds daily of this fodder, as from 15⅔ pounds of hay and 4½ pounds of cotton-seed meal. The volume of milk and value of excrement was greater, however, on the hay and meal ration.

TABLE VIII.—Showing Nutrients Consumed and Excreted in Ounces with percentages Digested.

BLACK GOAT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Sorghum fodder fed	211.64	185.33	9.66	20.31	14.58	9.62	95.09	50.65
Waste, sorghum fodder	30.24	24.94	2.12	2.82	2.13	1.05	12.67	6.28
Total consumed	181.40	160.39	7.54	17.49	12.45	8.57	82.42	44.37
Total solid excrement	139.22	64.32	6.21	7.09	7.09	4.53	30.90	15.58
Total digested	------	96.07	1.33	10.40	5.36	4.04	51.52	28.79
Per cent. digested	------	**59.89**	**17.64**	**59.46**	**43.05**	**47.14**	**62.51**	**64.88**

GRADE JERSEY COW, "SPOT."

Sorghum fodder fed	1440.0	1261.0	65.70	138.21	99.24	65.45	647.02	344.63
Waste, sorghum fodder	24.6	20.3	2.35	2.67	2.13	1.02	10.16	4.10
Total consumed	1415.4	1240.7	63.35	135.54	97.11	64.43	636.86	340.53
Total solid excrement	2802.8	418.2	37.18	51.23	51.23	34.63	213.03	82.13
Total digested	------	822.5	26.17	84.31	45.88	29.80	423.83	258.40
Per cent. digested	------	**66.29**	**41.31**	**62.20**	**47.23**	**46.25**	**66.55**	**75.88**
Mean of both animals	------	**63.09**	**29.47**	**60.83**	**45.14**	**46.69**	**64.53**	**70.38**
*Mean digestibility of pulled corn fodder (two animals)	------	**55.53**	**13.48**	**55.95**	**52.53**	**63.00**	**58.86**	**60.65**

Mean nutritive ratio of sorghum fodder 1:8.94.
*Mean nutritive ratio of corn fodder 1:8.73.

*Bulletin 87d, p. 7, N. C. Experiment Station.

It may be noted that although the correspondence between the percentages digested by the goat and cow is very close for protein and fat, it is rather wider for carbohydrates, and rather wide in ash. The cow seems to have digested this fodder rather better than did the goat.

In the digestion of pulled fodder from corn this goat digested protein and fat better than the sheep but fell behind the sheep in dry matter and carbohydrates, much as in this trial with sorghum fodder. While the mean digestibility of the pulled corn fodder differs in some respects considerably from that of sorghum fodder as found in the duplicated trials of each fodder, the real digestibility is doubtless nearer alike than appears from the comparison of means

afforded by the table. The sheep seemed less able to digest protein in the pulled corn fodder than the goat, and at the same time to surpass the goat in digesting carbohydrates, a difference which materially affects our comparison of mean coefficients. In the same way in the present trial the cow differs from the goat, but in a less degree, and the coefficients for cow and goat are no farther apart than might be found in duplicate trials with either animal.

V. DIGESTION OF PEANUT-VINE HAY,

BY BLACK AND GRAY GOATS.

Date of experiment, April, 1893.

Daily ration { Black goat, 900 grams. / Gray goat, 900 grams.

Total period, 14 days.

Collection period, the last 5 days.

Analytical and other data for obtaining coefficients of digestibility are contained in Tables IX and X.

The peanut-vine hay subjected to digestion in this experiment was in good condition and contained a considerable lot of "puffs" and some peanuts containing good meats. It was raised in a sandy soil in Edgecombe County upon the farm of Messrs. Battle & Howard.

This hay was eaten very well, and one goat maintained his weight on it while the other fell off a little. The percentages digested are very uniform, and show this part of the peanut plant in a very favorable light. The ratio is narrow enough to indicate this as a good coarse food and nearly a balanced ration in itself, indeed upon such a ration an animal may gain in a long period at smaller cost than could be obtained by a balanced ration and greater expense for a shorter time.

TABLE IX.—Showing percentage Composition of Peanut-vine Hay, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract	Crude fiber.
Peanut-vine hay	10.44	89.56	7.59	11.52	9.12	3.99	47.92	28.98
Waste, peanut-vine hay, gray goat	11.16	88.84	8.87	13.59	10.56	4.13	47.38	26.03
Waste, peanut-vine hay, black goat	12.54	87.46	6 57	10.26	8.75	4.44	44.35	34.38
Solid excrement, gray goat	52.22	47.78	14.19	10.08	10.08	3.70	36.34	35.69
Solid excrement, black goat	45.82	54 18	15.36	10 56	10.56	3.03	36.57	34.48

TABLE X.—Showing Nutrients Consumed and Excreted in Grams with percentages Digested.

GRAY GOAT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Peanut-vine hay fed	4500.0	4030.2	305.90	464.28	367.55	160.80	1931.27	1167.95
Waste, peanut-vine hay	837.0	743.6	65.95	101.05	78.52	30.71	352.31	193.56
Total consumed	.....	3286.6	239.95	363.23	289.03	130.09	1578.96	974.39
Total solid excrement	2788.0	1332.1	189.0	134.27	134.27	49.28	484.08	475.43
Total digested	.....	1954.5	50.95	228.96	154.76	80.81	1094.88	498.96
Per cent. digested	.....	**59.46**	**21.24**	**63.03**	**51.92**	**62.12**	**69.34**	**51.20**

BLACK GOAT.

Peanut-vine hay fed	4500.0	4030.2	305.90	464.28	367.55	160.80	1931.27	1167.95
Waste, peanut-vine hay	41.0	35.9	2.36	3.68	3.15	1.59	15.92	12.35
Total consumed	.....	3994.3	303.54	460.60	364.40	159.21	1915.35	1155.60
Total solid excrement	2930.4	1588.0	243.90	167.69	167.69	48.12	580.73	547.54
Total digested	.....	2406.3	59.64	292.91	196.71	111.09	1334.62	608.06
Per cent. digested	.....	**60.24**	**19.65**	**63.59**	**53.98**	**69.77**	**69.67**	**52.61**
Mean of both animals	.....	**59.85**	**20.44**	**63.31**	**52.95**	**65.94**	**69.50**	**51.90**

Mean nutritive ratio of peanut-vine hay 1:7.69.

VI. DIGESTION OF SORGHUM BAGASSE,

BY GRAY GOAT.

Date of experiment, February, 1893.

Daily ration, 900 grams, but only small portion was eaten.

Total period, 15 days.

Collection period, the last 5 days.

Analytical and other data for obtaining coefficients of digestibility are contained in Tables XI and XII.

The composition of the materials used in experiments VI and VII are shown in Table XI and the discussion of the results of the two experiments follow Table XIII.

TABLE XI.—Showing percentage Composition of Sorghum Bagasse, Cotton-seed Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract	Crude fiber.
Sorghum bagasse	11.25	88.75	3.24	3.87	3.40	1.62	56.87	34.40
Cotton-seed meal	7.03	92.97	6.20	42.33	41.65	12.73	31.77	6.97
Waste, sorghum bagasse, 1st experiment	11.96	88.04	3.14	4.27	3.69	1.72	55.23	35.64
Waste, sorghum bagasse, 2d experiment	11.26	88.74	4.07	4.75	4.06	1.81	55.82	33.55
Solid excrement, 1st experiment	51.47	48.53	7.23	8.07	8.07	2 14	51.44	31.12
Solid excrement, 2 l experiment	51.25	48.75	9.08	10 03	10.03	2.24	48.15	30.50

TABLE XII.—Showing Nutrients Consumed and Excreted in Grams with percentages Digested.

GRAY GOAT. FIRST EXPERIMENT, SORGHUM BAGASSE ALONE.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6 25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Sorghum bagasse fed	4500.0	3993.75	129.40	154.56	135.79	64.70	2271.24	1373.85
Waste, sorghum bagasse	1451.5	1277.90	40.13	54.57	47.15	21.98	705.78	455.44
Total consumed	3048.5	2715.85	89.27	99.99	88.64	42.72	1565.46	918.41
Total solid excrement	2204.5	1069.84	77.35	86.34	86.34	22.89	550.33	332.93
Total digested	.....	1646.01	11.92	13.65	2.30	19.83	1015.13	585.48
Per cent. digested	.....	**60.60**	**13.35**	**13.65**	**2.59**	**46.42**	**64.84**	**63.75**

VII. DIGESTION OF SORGHUM BAGASSE AND COTTON SEED MEAL,

BY GRAY GOAT.

Date of experiment, February and March, 1893.
Total period, 14 days.
Collection, the last 5 days.
Bagasse and meal fed in proportion of 4 to 1.
Bagasse and meal eaten in proportion of 1.86 to 1.
Analytical and other data for obtaining the coefficients of digestibility are presented in Tables XI and XIII.

TABLE XIII.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

GRAY GOAT. SECOND EXPERIMENT, RATION SORGHUM BAGASSE AND COTTON-SEED MEAL. FED 4 TO 1; EATEN 1.86 TO 1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Sorghum bagasse fed	4500.0	3993.75	129.40	154.56	135.79	64.70	2271.24	1373.85
Cotton-seed meal fed	1125.0	1045.91	64.85	442.73	435.62	133.14	332.29	72.90
Total fed	5625.0	5039.66	194.25	597.29	571.41	197.84	2603.53	1446.75
Waste, sorghum bagasse	2404.5	2133.75	86.84	101.35	86.63	38.62	1191.06	715.87
Total consumed	3220.5	2905.91	107.41	495.94	484.78	159.22	1412.47	730.88
Total solid excrement	2254.1	1098.87	99.78	110.21	110.21	24.61	529.11	335.15
Total digested	.....	1807.04	7.16	385.72	374.57	134.60	883.36	395.72
Digested from sorghum bagasse	....	1127.16	5.68	7.26	1.27	12.11	700.39	419.46
Digested from Cotton-seed meal	.....	679.88	1.95	378.46	373.30	122.49	182.97	.....
Per cent. of ration digested	.....	**62.18**	**7.10**	**77.77**	**77.27**	**84.54**	**62.54**	**54.14**
Per cent. of cotton-seed meal digested in ration	.....	**65.00**	**3.01**	**85.48**	**85.69**	**92.01**	**55.06**	.....

Nutritive ratio of sorghum bagasse, 1:120.8.

Nutritive ratio of ration of 1 pound cotton-seed meal to 1.86 pounds sorghum bagasse, 1:4.19.

This Station has grown several varieties of sorghum for two years, and distributed the seed among the farmers of the State not needed for the production of seed. Enough cane was produced in 1892 to make a small quantity of syrup. When the sorghum canes were ground, some of the bagasse was dried for this experiment. The fodder was also preserved for feeding and digestion. The goat ate sparingly of this food which was dry, hard, and uninviting. The juice had been thoroughly removed when the canes were ground and consequently was not very sweet after having been dried. Sorghum bagasse, when fresh, is sweet, to the taste and may be fed to some extent very readily, as cattle accept it more or less according to the thoroughness with which the juice is removed. When the expression of juice is thoroughly done, the bagasse is least attractive to animals; but when poorly done and much juice is left, it is most greedily eaten.

The bagasse under trial was nearly free from juice. The composition when analyzed was found to be very much like that of cotton-seed hulls. It contains less protein, fat, and crude fiber, and more nitrogen-free extract.

The close correspondence between the composition of bagasse and cotton-seed hulls points toward something in kind in the digestibility. This single determination marks the sorghum bagasse much more digestible than are cotton-seed hulls except in the fat, of which the hulls yield up a high percentage to the digestive fluids while but little "ether extract" present in the bagasse is digestible.

The percentages of this by-product digested are encouraging, in that they show a large amount of digestible carbohydrates which can easily be balanced by cotton-seed meal and thus produce very good cattle rations. If bagasse can be preserved in silos, and there is no reason why it cannot, sorghum growers and syrup makers on a large scale have a very cheap and valuable waste product to turn into growth of young stock and into beef.

A quantity of bagasse, from which juice was poorly removed, put into the bottom of one of the Station silos under corn, came out in good condition. Another lot, pressed out dryer, and stored on the top of another silo of corn, was too dry and was only fit for bedding and for mulching.

VIII. DIGESTION OF CRIMSON CLOVER HAY, ONE YEAR OLD,

BY BLACK GOAT AND COW, MISS HALEY.

Date of experiment, January, 1893.

Daily ration for goat, 3 pounds fed, 2.47 pounds eaten.

Daily ration for cow, 18 pounds fed, 15.07 pounds eaten.

Total period, 12 days for goat, and 13 days for cow.

Collection period, the last 5 days.

Analytical and other data for obtaining the coefficients of digestibility are contained in Tables XIV and XV.

TABLE XIV.—Showing Percentage Composition of Crimson Clover Hay, (one-year-old), Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumin'ids (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay	11.46	88.54	7.08	17.00	13.90	2.27	43.46	30.19
Waste, crimson clover hay, native cow, Miss Haley	10.52	89.48	8.82	22.20	18.62	2.38	45.83	20.77
Waste, crimson clover hay, black goat	9.79	90.21	8.24	15.51	12.25	2.95	45.77	27.53
Solid excrement, native cow, Miss Haley	83.30	16.70	6.36	13.88	13.88	3.16	37.75	38.85
Solid excrement, black goat	58.16	41.84	7.67	13.44	13.44	3.19	36.33	39.37

TABLE XV.—Showing Nutrients Consumed and Excreted in Ounces† with percentages Digested.

NATIVE COW, MISS HALEY.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albuminoids (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay (one-year-old) fed	1440.0	1275.0	90.27	216.75	177.23	28.94	554.12	384.92
Crimson clover hay, waste	235.4	210.6	18.57	46.75	39.21	5.01	96.52	43.74
Total consumed	1205.6	1064.4	71.70	170.00	138.02	23.93	457.60	341.18
Total solid excrement	2202.1	367.8	23.39	51.05	51.05	11.62	138.84	142.89
Total digested		696.6	48.31	118.95	86.97	12.31	318.76	198.29
Per cent. digested		65.44	67.37	69.97	63.01	51.44	69.66	58.12

BLACK GOAT.

Crimson clover hay (one-year-old) fed	240.00	212.50	15.05	36.13	29.54	4.82	92.35	64.15
Crimson clover hay, waste	42.18	38.05	3.14	5.90	4.66	1.12	17.42	10.48
Total consumed	197.82	174.45	11.91	30.23	24.88	3.70	74.93	53.67
Total solid excrement	180.17	75.38	5.78	10.13	10.13	2.40	27.39	29.68
Total digested		99.07	6.13	20.10	14.75	1.30	47.54	23.99
Per cent. digested		56.79	51.47	66.49	59.28	35.13	63.44	44.69
Mean of both animals (one year-old hay)		61.11	59.42	68.23	61.14	43.28	66.55	51.40
*Mean of two animals (new hay)		62	53.55	69.14	60.23	48.83	71.49	48.70

Mean nutritive ratio of one-year-old crimson clover hay, 1:4.47.
*Mean nutritive ratio new crimson clover hay, 1:3.76.

†One ounce, 28.35 grams.
*Bulletin 87d. Technical Bulletin No. 4, p. 9, N. C. Experiment Station.

The crimson clover hay fed in these experiments had been cut and stored in barn for more than a year, it being a portion of the same lot of hay, the digestibility of which was determined a year ago. Comparison of the compositions of the new and one-year-old hay shows a decrease of one per cent. in total protein but practically the same amount of albuminoids, slightly less fat, and an increase of nitrogen-free extract and crude fiber in the year-old hay. The new hay was slightly more digestible than the old; the decrease in the old hay falling upon the fat and nitrogen-free extract, but the difference in digestibility of total dry matter in the old and new hay is no more than would be expected to be found in different experiments with exactly the same food. The digestibility of the old hay was determined to see if it had deteriorated with age, and to use in rations to determine the digestibility of cotton-seed meal, corn meal, and corn and cob meal which follow later.

IX. DIGESTION OF CRIMSON CLOVER HAY AND COTTON-SEED MEAL,

BY COW, MISS HALEY AND GRAY GOAT.

Date of experiment, January, 1893.

Daily ration:

- Cow, "Miss Haley,"
  - 18 lbs. hay and 2¼ lbs. meal fed.
  - 14.43 lbs. hay and 2¼ lbs. meal eaten.
  - Proportion of hay to meal eaten, 6.4 to 1.
- Gray Goat,
  - 36 ounces hay and 9.0 ounces meal fed.
  - 27.81 ounces hay and 9.0 ounces meal eaten.
  - Proportion of hay to meal eaten 3.09 to 1.

Total periods, 16 days for Miss Haley, and 13 days for gray goat.

Collection period, the last 5 days for cow and last 4 days for goat.

Analytical and other data for obtaining the coefficients of digestibility are presented in Tables XVI and XVII.

TABLE XVI.—Showing percentage Composition of Crimson Clover Hay, Cotton-seed Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay	11.46	88.54	7.08	17.00	13.90	2.27	43.46	30.19
Cotton-seed meal	7.03	92.97	6.20	42 33	41.65	12.73	31.77	6.97
Waste, crimson clover hay, cow, Miss Haley	16.27	83.73	8.35	21.05	18.53	3.30	45.27	22.03
Waste, crimson clover hay, gray goat	11.00	89.00	8 08	19.28	16.56	2.60	47.26	22.78
Solid excrement, cow, Miss Haley	82.97	17.03	8.04	13.37	13.37	2.96	39.05	36.58
Solid excrement, gray goat	58.87	41.13	9.18	12.95	12.95	3.60	39.01	35.26

The clover hay fed in these experiments was the same as that the digestibility of which was determined in the previous experiment, No. 8. The digestibility of the hay having been determined, it was fed with cotton-seed meal, and from the digestibility of the hay and the ration the digestibility of the cotton-seed meal was calculated. It was the original plan, in the experiments which precede and follow, to determine the digestibility of cotton-seed meal, to feed the meal and hay in two proportions, viz.: 1 to 8 and 1 to 4. The object being to ascertain if the coefficients for the meal in the two rations would agree. The animals, however, did not eat the rations as they were fed, and the original plan was somewhat interfered with. All the results will be considered after the presentation of the next two

experiments. It should be said that the digestibility of the ration of 8 pounds hay to 1 pound meal (fed) was determined in duplicate, but the results of one experiment were considered erroneous and for that reason are withheld from publication.

TABLE XVII.—Showing Nutrients Consumed and Excreted in Ounces*, with Percentages Digested.

COW, MISS HALEY. RATION: CRIMSON CLOVER HAY AND COTTON-SEED MEAL 6.4 TO 1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay fed	1440.0	1275.0	90.27	216.75	177.23	28.94	554.12	384.92
Cotton-seed meal fed	180.0	167.3	10.37	70.82	69.68	21.30	53.15	11.66
Total fed	1620.0	1442.3	100.64	287.57	246.91	50.24	607.27	396.58
Waste, crimson clover hay	285.5	239.0	19.96	50.31	44.29	7.89	108.20	52.65
Total consumed	1334.5	1203.3	80.68	237.26	202.62	42.35	499.07	343.93
Total solid excrement	2691.9	458.4	36.86	61.29	61.29	13.56	179.01	167.68
Total digested	.....	744.9	43.82	175.97	141.33	28.79	320.06	176.25
Digested from crims'n clover hay	.....	633.1	41.77	113.56	81.28	9.11	296.76	170.79
Digested from cotton-seed meal	.....	111.8	2.05	62.41	60.05	19.68	23.30	5.46
Per cent. of ration digested	.....	**61.90**	**54.31**	**74.17**	**69.75**	**67.98**	**64.13**	**51.24**
Per cent. of cotton-seed meal digested	.....	**66.82**	**19.77**	**88.12**	**86.18**	**92.39**	**43.84**	**46.83**

GRAY GOAT. RATION: CRIMSON CLOVER HAY AND COTTON-SEED MEAL 3.09 TO 1.

Crimson clover hay fed	144.00	127.50	9.03	21.68	17.72	2.89	55.41	38.49
Cotton-seed meal fed	36.00	33.47	2.08	14.17	13.94	4.26	10.63	2.33
Total fed	180.00	160.97	11.11	35.85	31.66	7.15	66.04	40.82
Waste, crimson clover hay	32.76	29.16	2.36	5.62	4.83	.76	13.78	6.64
Total consumed	147.24	131.81	8.75	30.23	26.83	6.39	52.26	34.18
Total solid excrement	106.03	43.61	4.00	5.65	5.65	1.57	17.01	15.38
Total digested	.....	88.20	4.75	24.58	21.18	4.82	35.25	18.80
Digested from crims'n clov'r hay	.....	60.10	3.96	10.96	7.88	.92	27.70	16.37
Digested from cotton-seed meal	.....	28.10	.79	13.62	13.30	3.90	7.55	2.43
Per cent. of ration digested	.....	**66.91**	**54.28**	**81.31**	**78.94**	**75.43**	**67.45**	**55.00**
Per cent. of cotton-seed meal digested	.....	**83.95**	**37.98**	**96.12**	**95.41**	**91.55**	**71.02**	**100.00**

Nutritive ratio of ration of 6.4 pounds crimson clover hay to 1 ponnd cotton-seed meal, 1 to 3.73.

Nutritive ratio of ration of 3.09 pounds crimson clover hay to 1 pound cotton-seed meal, 1 to 2.68.

*One ounce, 28.35 grams.

X. DIGESTION OF CRIMSON CLOVER HAY AND COTTON-SEED MEAL,

BY GRADE JERSEY COW, "SPOT."

Date of experiment, January and February, 1893.

Daily ration:

- First period,
  - 18 pounds hay and 4½ pounds meal fed.
  - 15.74 pounds hay and 4½ pounds meal eaten.
  - Proportion of hay to meal eaten 3.5 to 1.
- Second period,
  - 18 pounds hay and 4½ pounds meal fed.
  - 15.88 pounds hay and 4½ pounds meal eaten.
  - Proportion of hay to meal eaten 3.53 to 1.

Total periods, 27 days; 13 for first and 14 for second.

Collection periods, the last 4 days for first; and the last 5 days for second.

Analytical and other data for obtaining the coefficients of digestibility are presented in Tables XVIII and XIX.

Three determinations of digestibility of the ration of 4 pounds clover hay to 1 pound cotton-seed meal (fed) were made, the results of two determinations being presented in Table XIX and those of the third in Table XVII along with the results for the 8 to 1 ration. It was hoped to obtain from these two sets of experiments some evidence as to whether the clover hay or cotton-seed meal exerted any influence on the digestibility of the other in the rations, but the calculated coefficients for cotton-seed meal, even in the same ration, are too wide to allow any conclusions to be drawn. The coefficients of digestibility of the rations are quite concordant, but since the meal

TABLE XVIII.—Showing percentage Composition of Crimson Clover Hay, Cotton-seed Meal, Waste and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N ×6 25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay	11.46	88.54	7.08	17.00	13.90	2.27	43.46	30.19
Cotton-seed meal	7.03	92.97	6.20	42.33	41.65	12.73	31.77	6.97
Waste, crimson clover hay, grade Jersey cow, "Spot," 1st period	10.08	89.92	7.95	17.79	14.80	2.59	43.78	27.89
Waste, crimson clover hay, 2d period	15.56	84.44	8.64	17.46	13.75	2.85	41.65	29.40
Solid excrement, grade Jersey cow, "Spot," 1st period	81.05	18.95	8.23	15 50	15.50	3 54	38.36	34.37
Solid excrement, 2d period	84.59	15.41	8.73	15.89	15.89	3.76	36.70	34.92

TABLE XIX.—Showing Nutrients Consumed and Excreted in Ounces*, with percentages Digested.

GRADE JERSEY COW, SPOT, 1ST PERIOD. RATION: CRIMSON CLOVER HAY AND COTTON-SEED MEAL, 3.5 to 1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6 25)	Albumi'ds Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay fed	1152.0	1020.0	72.22	173.40	141.78	23.15	443.29	307.94
Cotton-seed meal fed	288.0	267.7	16.60	113.32	111.50	34.08	85.05	18.66
Total fed	1440.0	1287.7	88.82	286.72	253.28	57.23	528.34	326.60
Waste, crimson clover hay	144.3	129.8	10.32	23.09	19.21	3.36	56.83	36.20
Total consumed	1295.7	1157.9	78.50	263.63	234.07	53.87	471.51	290.40
Total solid excrement	2286.6	433.3	35.66	67.16	67.16	15.34	166.21	148.93
Total digested	.....	724.6	42.84	196.47	166.91	38.53	305.30	141.47
Digested from crimson clover hay	.....	544.0	36.78	102.56	74.94	8.57	257.18	139.67
Digested from cotton-seed meal	.....	180.6	6.06	93.91	91.97	29.96	48.12	1.80
Per cent. of ration digested	.....	62.57	54.57	74.52	71.31	71.52	64.75	48.71
Per cent. of cotton-seed meal digested	.....	67.46	36.50	82.87	82.48	87.91	56.58	9.64

GRADE JERSEY COW, SPOT, 2D PERIOD. RATION: CRIMSON CLOVER HAY AND COTTON-SEED MEAL, 3.5 TO 1.

Crimson clover hay fed	1440.0	1275.0	90.27	216.75	177.23	28.94	554.12	384.92
Cotton-seed meal fed	360.0	334.6	20.74	141.64	139.36	42.60	106.30	23.32
Total fed	1800.0	1609.6	11.01	358.39	316.59	71.54	660.42	408.24
Waste, crimson clover hay	169.5	143.1	12.36	24.99	19.68	4.08	59.60	42.07
Total consumed	1630.5	1466.5	98.65	333.40	296.91	67.46	600.82	366.17
Total solid excrement	3402.1	524.3	45.77	83.31	83.31	19.71	192.42	183.09
Total digested	.....	942.2	52.88	250.09	213.60	47.75	408.40	183.08
Digested from crimson clover hay	.....	691.7	46.29	130.84	96.33	10.75	329.10	176.22
Digested from cotton-seed meal	.....	250.5	6.59	119.25	117.27	37.00	79.30	6.86
Per cent. of ration digested	.....	64.25	53.60	75.01	71.94	70.78	67.97	50.00
Per cent. of cotton-seed meal digested	.....	74.86	31.77	84.19	84.15	86.85	74.60	29.41
Mean per cent. of above two rations digested	.....	63.41	54.08	74.77	71.62	71.15	66.36	49.35
Mean per cent. of cotton-seed meal digested in four experiments	.....	73.3	31.5	87 8	87.1	89.7	61.5	46.4

Mean nutritive ratio of rations of 3.5 and 3.53 pounds crimson clover hay to 1 pound cotton-seed meal, 1 to 2.81.

*One ounce, 28.35 grams.

forms rather a small part of the rations and all differences in digestibility of rations from whatever cause fall upon the calculated coefficients for meal, they have been made quite divergent. It is considered, however, that the average results presented at the foot of Table XIX gives a fairly correct idea of the digestibility of cotton-seed meal. The digestibility of cotton-seed meal has also been determined by Wolff and Armsby. Their work was done upon the meal of ten years ago; and that used by Armsby, as shown by analysis,* contained more oil and *much less fiber* than the meals of the present day, which means that the oil is more completely removed by modern machinery and indicates that either the hulls and kernels are not so well separated now, or else hulls are ground in with the meal. We present below the results of Wolff and Armsby,* and those obtained at this Station for the digestibility of cotton-seed meal.

	Wolff's experiments.	Armsby's experiments.	Average of Wolff's and Armsby's.	Our experiments.	Average of all.
Dry matter	74.0	81.5	77.8	73.3	76 3
Protein	84.7	88.8	86.8	87.5	87.1
Albuminoids	....	....	....	87.1	....
Fat	87.6	100.0	93.8	89.7	92.4
Nitrogen-free extract	83 7	68.9	76.3	61.5	71.4
Crude fiber	0.0	0.0	0.0	46.4	....

*Bulletin No. 3, Wisconsin Experiment Station.

XI. DIGESTION OF COTTON-SEED HULLS AND MEAL IN RATIONS 3 TO 1 AND 2.8 TO 1,

BY OLD STEERS LOPHORN AND YELLOW 2d.

Date of the experiment, January and February, 1892.

Daily ration offered, { 18 pounds hulls and 6 lbs. of meal to Yellow. / 21 pounds hulls and 7½ lbs. meal to Lophorn. } all consumed.

Total period, 18 days.

Collection period, the last 5 days.

Analytical and other data for obtaining the coefficients of digestibility are given in Tables XX and XXI.

This is a continuation of the digestion experiments in narrowing the ratio between hulls and meal fed. The steers to which these rations were fed took on fat and throve under the heavy feeding of

cotton-seed meal and were carried forward to the next experiment in good condition. It will be noted that the nutritive ratios have been narrowed to about the German standard for fattening in these trials of feeding, in the proportion of 3 pounds of hulls to 1 pound of meal. A little waste hulls would vary the ration toward the standard for a second fattening period, while addition of a little more of hulls would reach the wider ratio for the first fattening period. Compared with digestion of ration of four pounds of hulls to one of meal, about the same amount of total dry matter is shown to be digested, more protein and albuminoids, about the same per cent. of fat, less nitrogen-free extract, and more crude fiber. This difference in the relations of the amounts of the various constituents digested tends to a narrowing of the nutritive ratio.

TABLE XX.—Showing Percentage Composition of Cotton-seed Hulls, Cotton-seed Meal, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats (Ether extract)	N free extract.	Crude fiber.
Cotton-seed hulls	12.35	87.65	1.88	4.82	4.82	3.13	40.57	49.60
Cotton-seed meal	7.03	92.97	6.20	42.33	41.65	12.73	31.77	6.97
Solid excrement, steer, Yellow 2d	71.36	28.64	4.75	12.66	12.66	1.63	37.96	43.00
Solid excrement, Lophorn steer	75.90	24.10	4.24	11.76	11.76	1.88	37.98	44.14

TABLE XXI.—Showing Nutrients Consumed and Excreted in Ounces*, with Percentages Digested.

STEER, YELLOW 2D. RATION: COTTON-SEED HULLS AND MEAL, 3:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Cotton-seed hulls fed	1440.0	1262.2	23.73	60.84	60.84	39.51	512.07	626.05
Cotton-seed meal fed	480.0	446.3	27.67	188.92	185.88	56.81	141.79	31.11
Total consumed	1920.0	1708.5	51.40	249.76	246.72	96.32	653.86	657.16
Total solid excrement	2687.5	769.7	36.56	97.44	97.44	12.55	292.18	330.97
Total digested		938.8	14.84	152.32	149.28	83.77	361.68	326.19
Digested from cotton-seed meal		327.1	8.72	165.87	161.90	50.96	87.20	14.44
Digested from cotton-seed hulls		611.7	6.12	-13.55	-12.62	32.81	274.48	311.75
Per cent. of ration digested		**54.95**	**28.87**	**60.98**	**60.50**	**86.96**	**55.31**	**49.63**
Per cent. of cotton-seed hulls digested		**48.46**	**25.79**			**83.04**	**53.60**	**49.79**

*One ounce, 28.35 grams.

TABLE XXI.—Showing Nutrients Consumed and Excreted in Ounces*, with Percentages Digested—Continued.

LOPHORN STEER. RATION: COTTON-SEED HULLS AND MEAL, 2.8:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract.)	N-free extract.	Crude fiber.
Cotton-seed hulls fed	1680.0	1472.5	27.68	70.97	70.97	46.09	597.39	730.36
Cotton-seed meal fed	600.0	557.8	34.58	236.12	232.32	71.01	177.21	38.88
Total consumed	2280.0	2030.3	62.26	307.09	303.29	117.10	774.60	769.24
Total solid excrement	4082.3	983.8	41.71	115.69	115.69	18.50	373.65	434.25
Total digested	.....	1046.5	20.55	191.40	187.60	98.60	400.95	334.99
Digested from cotton-seed meal	.....	408.9	10.89	207.31	202.35	63.69	108.98	18.04
Digested from cotton-seed hulls	.....	637.6	9.66	-15.91	-14.75	34.91	291.97	316.95
Per cent. of ration digested	.....	51.54	33.01	62.33	61.82	84.20	51.76	43.55
Per cent. of cotton-seed hulls digested	.....	43.30	34.89	.....	.....	75.74	48.88	43.39

Nutritive ratio of ration of 3 pounds cotton-seed hulls to 1 pound cotton-seed meal, 1 to 5.89.

Nutritive ratio of ration of 2.8 pounds cotton-seed hulls to 1 ponnd cotton-seed meal, 1 to 5.13.

*One ounce, 28.35 grams.

XII. DIGESTION OF COTTON-SEED HULLS AND MEAL IN RATIONS OF 2 TO 1,

BY OLD STEERS LOPHORN AND YELLOW 2D.

Date of the experiment, February, 1893.

Total period for first part of ration 2 to 1, 14 days.

Collection period, the last 5 days.

Rations fed, { Lophorn, 21 pounds hulls 10½ pounds meal. Yellow 2d, 18 pounds hulls 9 pounds meal.

Lophorn left waste which reduced the ratio eaten to 2.4 to 1. Yellow 2d ate the ration clean for 35 days to the end of the digestion period with it, and continued to eat it until changed on the 58th day. Lophorn ate heartily all the time but never cleaned his feed-box well. The steers remained in good condition throughout all the feeding.

Analytical and other data for obtaining the coefficients of digestibility are given in Tables XXII and XXIII.

This is heavy feeding with cotton-seed meal. The proportion of the ration digested has ceased increasing. This may be due to the heavy ration having carried more nutriment than the steer could

TABLE XXII.—Showing Percentage Composition of Cotton-seed Hulls and Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Cotton-seed hulls	12.35	87.65	1.88	4.82	4.82	3.13	40.57	49.60
Cotton-seed meal	7.03	92.97	6.20	42 33	41.65	12.73	31.77	6.97
Waste, cotton-seed hulls, Lophorn steer	8.96	91.04	4.55	29.04	27.19	9.88	30.92	25.61
Waste, cotton-seed meal, Lophorn steer	7.82	92.18	5.93	40.75	40.12	14.42	30.01	8.89
Waste, cotton-seed meal, Yellow 2d, 1st experiment	8.58	91.42	6.33	14.07	43.81	14.98	28.35	6.73
Solid excrement, Lophorn steer	76.90	23.10	4.64	12.94	12.94	2.00	36.91	43.51
Solid excrement, Yellow 2d, 1st experiment	71.44	28.56	5.45	13.56	13.56	3.04	45.51	34.44
Solid excrement, Yellow 2d, 2d experiment	72.23	27.77	5.16	13.47	13 47	1.83	37.96	41.58

TABLE XXIII.—Showing Nutrients Consumed and Excreted in Ounces* with Percentages Digested.

LOPHORN STEER. RATION: COTTON-SEED HULLS AND MEAL, 2.4:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Cotton-seed hulls fed	1680.0	1472.5	27.68	70.97	70.97	46.09	597.39	730.36
Cotton-seed meal fed	840.0	780.9	48.42	330.55	325.24	99.41	248.09	54.43
Total fed	2520.0	2253.4	76.10	401.52	396.21	145.50	845.48	784.79
Waste, cotton-seed hulls	26.5	24.1	1.10	7.00	6.55	2.38	7.45	6.17
Waste, cotton-seed meal	153.1	141.1	8.37	57.50	56.61	20.34	42.34	12.54
Total waste	179.6	165.2	9.47	64.50	63.16	22.72	49.79	18.71
Total consumed	2340.4	2088.2	66.63	337.02	333.05	122.78	795.69	766.08
Total solid excrement	4335.0	1001.4	46.46	129.58	129.58	20.03	369.62	435.71
Total digested	------	1086.8	20.17	207.44	203.47	102.75	426.07	330.37
Digested from cotton-seed meal	------	468.9	12.62	239.74	233.98	70.93	126.54	19.44
Digested from cotton-seed hulls	------	617.9	7.55	-32.30	-30.51	31.82	299.53	310.93
Per cent. of ration digested	------	**52.04**	**30.27**	**61.55**	**61.09**	**83.68**	**53.55**	**43.12**
Per cent. of cotton-seed hulls digested	------	**42.66**	**28 40**	------	------	**72.79**	**50.77**	**42.93**

*One ounce, 28.35 grams.

TABLE XXIII.—Showing Nutrients Consumed and Excreted in Ounces*, with Percentages Digested—Continued.

YELLOW 2D, 1ST EXPERIMENT. RATION: COTTON SEED HULLS AND MEAL, 2.02:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Cotton-seed hulls fed	1440.0	1262.2	23.73	60.84	60.84	39.51	512.07	626.05
Cotton-seed meal fed	720.0	669.4	41.50	283.35	278.81	85.21	212.67	46.66
Total fed	2160.0	1931.6	65.23	344.19	339.65	124.72	724.74	672.71
Waste, cotton-seed meal	7.4	6.8	.43	3.00	2.98	1.02	1.91	.46
Total consumed	2152.6	1924.8	64.80	341.19	336.67	123.70	722.83	672.25
Total solid excrement	3244.0	926.5	50.49	125.63	125.63	28.17	403.12	319.09
Total digested		998.3	14.31	215.56	211.04	95.53	319.71	353.16
Digested from cotton-seed meal		485.7	12.94	246.15	240.25	75.52	129.62	21.44
Digested from cotton-seed hulls		512.6	1.37	-30.59	-29.21	20.01	190.09	331.72
Per cent. of ration digested		51.86	22.08	63.18	62.68	77.22	44.23	52.53
Per cent. of cotton seed hulls digested		40.61	5.77			50.64	37.12	52.98

YELLOW 2D, 2D PERIOD. RATION: COTTON-SEED HULLS AND MEAL, 2:1.

Cotton-seed hulls fed	1440.0	1262.2	23.73	60.84	60.84	39.51	512.07	626.05
Cotton-seed meal fed	720.0	669.4	41.50	283.35	278.81	85.21	212.67	46.66
Total consumed	2160.0	1931.6	65.23	344.19	339.65	124.72	724.74	672.71
Total solid excrement	3114.2	864.8	44.62	116.49	116.49	15.83	328.28	359.58
Total digested		1066.8	20.61	227.70	223.16	108.89	396.46	313.13
Digested from cotton-seed meal		490.7	13.07	248.78	242.84	76.43	130.79	21.65
Digested from cotton-seed hulls		576.1	7.54	-21.08	-19.68	32.46	265.67	291.48
Per cent. of ration digested		55.23	31.59	66.16	65.70	87.30	54.70	46.54
Per cent. of cotton-seed hulls digested		45.64	31.77			82.16	51.88	46.56
Mean of two trials on ration by Yellow 2d		53.55	26.84	64.67	64.19	82.26	49.47	49.53

Nutritive ratio of ration consumed as 2.4 pounds cotton-seed hulls to 1 pound cotton-seed meal, 1:4.88.

Mean nutritive ratio of ration consumed as 2 pounds cotton-seed hulls to 1 pound cotton-seed meal, 1:4.27.

*One ounce, 28.35 grams.

well digest. If so, then a limitation of appetite and feeding in the same ratio might have carried the increasing digestibility of hulls with relatively increasing amounts of cotton-seed meal farther than has been found. As far as carried, the digestibility of cotton-seed hulls reached a maximum when there were three pounds of hulls

eaten to one pound of cotton-seed meal. This is more plainly shown in Table XXIV than in the tables containing the usual data.

The digestibility of the cotton-seed hulls fed in these experiments with cotton-seed meal has been calculated by using the coefficients obtained for the cotton-seed meal from the experiments with crimson clover hay and cotton-seed meal (Nos. 9 and 10 of this bulletin). The minus percentages shown for protein in Table XXIV indicate the retardation of the digestibility of the protein of the meal fed in per cent. of that fed in the hulls. It is as though no protein has been digested from the hulls while they have retarded the digestibility of the protein of the meal, as fed with the clover hay, by an amount ranging from 12.6 per cent. of the protein contained in the hulls with the ration 7 to 1, to 50.49 per cent. of the protein contained in the hulls with the ration 2.4 to 1. But the loss in protein is more than counterbalanced by the increased digestibility of carbohydrates. The gains in nitrogen-free extract and crude fiber were sufficient to increase, after bringing up the loss from protein, the digestible dry matter from .81 per cent. in the 7 to 1 ration to 8.66 in the 3 to 1 ration.

TABLE XXIV.—Digestibility of Cotton-seed Hulls fed Alone and with Different Proportions of Cotton-seed Meal.

	Total dry matter.	Ash.	Protein (N×6.25)	Fat. (Ether extract)	N-free extract.	Crude fiber.
Average per cent. digested from cotton-seed hulls fed alone*	39.8	19.9	6.75	85.1	36.9	43.1
Per cent. digested from cotton-seed hulls consumed with meal in proportion of 7 to 1*	40.61	35.10	—12.60	78.41	50.24	33.52
Average per cent. digested from cotton-seed hulls when fed with meal in proportion of 6 to 1 with some waste assumed to have been all hulls*	41.12	22.02	—35.71	78.02	48.00	40.08
Per cent. digested from cotton-seed hulls when fed with meal in proportion of 4 to 1 with some waste assumed to have been all hulls*	47.72	59.01	—36.02	78.93	57.11	44.95
Per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 3 to 1	48.46	25.79	—22.27	83.04	53.60	49.79
Per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 2.8 to 1	43.30	34.89	—22.42	75.74	48.88	43.39
Per cent. digested from cotton seed hulls when consumed with cotton-seed meal in proportion of 2.4 to 1	42.66	28.40	—50 49	72.79	50.77	42.93
Average per cent. digested from cotton-seed hulls when consumed with cotton-seed meal in proportion of 2 to 1	43.12	18.77	—42 46	66.40	44.50	49.77

*From Bulletin 87d, Tech. Bulletin No. 4, pp. 34–46, N. C. Experiment Station.

XIII. DIGESTIBILITY OF CORN SILAGE ALONE, AND IN RATIONS WITH COTTON-SEED MEAL.

Using the coefficients for cotton-seed meal obtained by us, the digestibility of corn silage in rations of corn silage and cotton-seed meal has been calculated and the results are presented along with the coefficients for silage when fed alone, in Table XXV. These figures indicate quite a decided increase in the digestibility of the silage from the presence of the meal. These results have been re-calculated from Bulletin 87d.

TABLE XXV.—Showing the Digestibility of Corn Silage when fed Alone and with Different Proportions of Cotton-seed Meal.

	Dry matter.	Ash.	Total Protein.	Albuminoids.	Fats.	N-free extract.	Crude fiber.
Per cent. of corn silage digested when fed alone*	53.17	26.89	34.41	26.39	66.04	60.53	43.17
Average per cent. of corn silage digested when fed with cotton-seed meal in proportion of 12 pounds fresh silage to 1 pound meal†	60.14	5.51	18.97	10.71	79.25	68.94	57.50
Per cent. corn silage digested when fed with cotton-seed meal and consumed in proportion of 8 pounds fresh silage to 1 pound meal‡	67.36	37.18	24.52	2.33	54.70	76.27	64.33

*Experiment No. 5, Bulletin 87d, Technical Bulletin No. 4, p. 15, N. C. Experiment Station.

†Experiment No. 8, Bulletin 87d, Technical Bulletin No. 4, p. 23, N. C. Experiment Station. The wastes in these two experiments were considered in making the above calculations as though they were all silage, but they contained a very small amount of cotton-seed meal as is shown by their compositions. The meal present would have had very little effect in changing the above figures.

‡Experiment No. 9, steer No. 1., Bulletin 87d, Technical Bulletin No. 4, p. 28, N. C. Experiment Station. Steer No. 2 was not used in this calculation on account of the large amount of mixed waste of silage and meal left by him. He digested practically the same from the ration as did steer No. 1.

XIV. DIGESTION OF CORN MEAL ALONE,

BY GRAY GOAT.

Date of experiment, April and May, 1893.

Daily ration, 600 grams corn meal; eaten 208.86 grams of meal.

Total period, 20 days.

Collections, the last 5 days.

Analytical and other data for obtaining coefficients of digestibility are given in Tables XXVI and XXVII.

TABLE XXVI.—Showing Percentage Composition Corn Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Corn meal	12.68	87.32	1.51	10 08	10.08	5.03	81.60	1.78
Waste, corn meal	11.75	88.25	1.86	10.37	10.37	4 87	80.68	2.22
Solid excrement	79.02	20.98	11.17	24.06	19.42	7 96	36.78	20.03

TABLE XXVII.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

GRAY GOAT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6 25)	Albumi'ds (Alb. N ×6.25)	Fats (Ether extract)	N free extract.	Crude fiber.
Corn meal fed	3000.0	2619.6	39.56	264.05	264.05	131.77	2137.59	46.63
Waste, corn meal	1955.7	1725.9	32.10	178.97	178.97	84.05	1392.46	38.31
Total consumed		893.7	7.46	85.08	85.08	47.72	745.13	8.32
Total solid excrement	558.0	117.1	13.08	28.17	22.74	9.32	43.07	23.46
Total digested		776.6		56.91	62.34	38.40	702.06	
Per cent. digested		86.89		66.89	73.27	80.47	94 22	

Nutritive ratio of corn meal 1:14.02.

The digestibility and relative feeding value of corn-and-cob meal, and corn meal were desired. The plan to obtain these was to feed both with crimson clover hay, the digestibility of which had been determined. Then the meals would be exchanged and fed to the same two animals to obtain one trial of each meal with each of the goats used for the digestion. Following this the gray goat was fed a period exclusively on corn meal, and the black goat on corn-and-cob meal.

The corn used was grown on a neighboring farm. It was a mixed sample of Dent corn, part being deep kernels on small cobs, and part shallow kernels on large cobs. The larger cobs showed some traces of mould in curing.

The goat did not eat the corn meal alone very readily, and the amount consumed is quite small as is also the dung excreted. The dung contained considerable mucus, and non-albuminoids to the amount of 4.64 per cent. of the total dung. Albuminoids were determined by the Stutzer method; finding soluble protein not precipitable by copper hydrate was rather a surprise, since all the protein of the corn meal fed was in the form of albuminoids, as is seen

from the analysis. In all the experiments with corn meal, corn-and-cob meal, and rations of these with crimson clover hay, soluble protein was present in the dungs, and to an extent that we think could hardly be accounted for by the presence of mucus, bile, and other intestinal products. In all the other experiments reported in this bulletin, albuminoids were determined in the dungs, and found to agree with total protein, and much narrower ratio rations of cotton-seed meal and hulls, and crimson clover hay were fed than those of corn meal and corn-and-cob meal and crimson clover hay. It would seem, therefore, that the albuminoids of the corn meal and corn-and-cob meal have undergone change in the digestive tract. In consequence of this, albuminoids in all the experiments with corn meal and corn and-cob meal have a real and an apparent digestibility and coefficients are presented for each; the greater and upper coefficients in the columns of albuminoids representing apparent digestibility; and the smaller ones, real digestibility. The real digestibility of albuminoids and that of protein in this trial with corn meal alone are the same, and are represented by the coefficient for protein, that for albuminoids being apparent. The coefficients for corn meal in this experiment make an excellent showing for it as a food. Especial attention is directed to the high digestibility of nitrogen-free extract, which is largely starch and forms 81.6 of the total dry matter of the corn meal.

XV. DIGESTION OF RATION OF CORN MEAL FED WITH CRIMSON CLOVER HAY,

BY GRAY GOAT AND BLACK GOAT.

Date of experiment, March and April, 1893.

Daily ration:

- Black goat, { Fed 900 grams hay, 300 grams meal; eaten 708.8 grams hay, 300 grams meal Proportion of hay to meal eaten, 1.83 to 1.
- Gray goat, { Fed 900 grams hay, 300 grams meal; eaten 549.3 grams hay, 300 grams meal. Proportion of hay to meal eaten, 2.36 to 1.

Total period, 13 days for gray goat and 15 days for black goat.
Collection period, the last 5 days in both cases.

Analytical and other data for obtaining the coefficients of digestibility are given in Tables XXVIII and XXIX.

A portion of the same corn meal fed in the previous trial of corn meal alone was used in this experiment, as also the same clover hay before reported. The goats were fed corn meal and crimson clover hay in the proportion of 3 to 1, but consumed them as 1.83 and 2.36 to 1. The coefficients of digestibility of the rations are quite high, and differ considerably, though not more so than often occur in experiments of this kind. The average coefficients make a most excellent showing for the digestibility of these rations.

The coefficients of digestibility of the corn meal in these rations, calculated from the digestibility of the rations and crimson clover hay alone, are, while differing considerably, on an average higher than those for corn meal fed alone. The two sets of coefficients presented for albuminoids will be understood by reference to the similar part of the discussion of the trial of corn meal alone. Even then, the real digestibility of the albuminoids of corn meal in the rations appears to be greater than the total protein, which we can only account for on the supposition that some of the amides of the clover hay, which were all digested when the hay was fed alone, escaped digestion in the rations and appeared with the soluble protein from the corn meal in the dung, thus causing too large a coefficient to be used for total protein for crimson clover hay as digested in the rations. This difference occurs in the rations of corn meal and crimson clover hay, and corn-and-cob meal and crimson clover hay, though the difference in the former case is quite small.

TABLE XXVIII.—Showing Percentage Composition of Crimson Clover Hay, Corn Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N ×6 25)	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay	12.33	87.67	8.20	16.41	13.70	2.40	44.59	28.40
Corn Meal	12.68	87.32	1.51	10.08	10.08	5.03	81.60	1.78
Waste, crimson clover hay, gray goat	16.42	83.58	8.28	17.82	15.50	2.48	44.59	26.83
Waste, crimson clover hay, black goat	12.23	87.77	11.78	17.19	14.87	2.19	44.57	24.27
Solid excrement, gray goat	58 48	41.52	8 49	15.41	13.19	3 46	35.46	37.18
Solid excrement, black goat	59.37	40.63	10.29	17.31	13 87	3.27	33 20	35.93

TABLE XXIX.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

GRAY GOAT. RATION: CRIMSON CLOVER, HAY AND CORN MEAL, 1.83:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb. N ×6 25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay fed	4500.0	3945.2	323.51	647.41	540.49	94.68	1759.16	1120.44
Corn meal fed	1500.0	1309.8	19.78	132.03	132.03	65.88	1068.80	23.31
Total fed	6000.0	5255.0	343.29	779.44	672.52	160.56	2827.96	1143.75
Waste, crimson clover hay	1753.5	1465.6	121.35	261.17	227.16	36.35	653.5	393.22
Total consumed	.....	3789.4	221.94	518.27	445.36	124.21	2174.46	750.53
Total solid excrement	2385.3	990.4	84.09	152.62	130.63	34.27	351.2	368.24
Total digested	.....	2799.0	137.85	365.65	314.73	89.94	1823.26	382.29
Digested from crimson clover hay	.....	1515.3	120.12	263.53	191.57	25.24	735.82	373.79
Digested from corn meal	.....	1283.7	17.73	102.12	123.16	64.70	1087.44	8.50
Per cent. of ration digested	.....	73.60	62.11	70.55	70.66 65.73	72.41	83.84	50.93
Per cent. of corn meal digested	.....	98.00	91.96	77.34	93.28 76.63	98.20	100.00	36.46

BLACK GOAT. RATION: CRIMSON CLOVER HAY AND CORN MEAL, 2.36:1.

Crimson clover hay fed	4500.0	3945.2	323.51	647.41	540.49	94.68	1759.16	1120.44
Corn meal fed	1500.0	1309.8	19.78	132.03	132.03	65.88	1068.80	23.31
Total fed	6000.0	5255.0	343.29	779.44	672.52	160.56	2827.96	1143.75
Waste, crimson clover hay	956.0	839.1	98.85	144.24	124.77	18.38	373.99	203.65
Total consumed	.....	4415.9	244.44	635.20	547.75	142.18	2453.97	940.10
Total solid excrement	3402.0	1382.2	142.23	239.26	191.71	45.2	458.9	496.62
Total digested	.....	3033.7	102.21	395.94	356.04	96.98	1995.07	443.48
Digested from crimson clover hay	.....	1898.1	133.49	343.31	254.17	33.02	921.83	471.23
Digested from corn meal	.....	1135.6	.....	52.63	101.87	63.96	1073.24	.....
Per cent. of ration digested	.....	68.69	41.81	62.33	65.00 56.32	68.21	81.26	47.17
Per cent. of corn meal digested	.....	86.70	.....	39.86	77.15 41.14	97.09	100.00	.....
Mean per cent. of above two rations digested	.....	71.15	51.96	66.44	67.83 61.02	70.31	82.55	49.05
Mean per cent. of corn meal digested in above rations	.....	92.35	45.98	58.60	85.21 58.88	97.65	100.00	18.23

Nutritive ratio of rations of crimson clover hay and corn meal when consumed as 1.83 to 1, 1 to 6.64; when consumed 2.36 to 1, 1:6.77.

In Table XXX, are brought together for comparison the coefficients of digestibility of corn meal when fed alone to goats and pigs, when fed in ration with orchard grass hay to cows, and in rations with crimson clover hay to goats. The corn meal appears to have been better digested in the rations with crimson clover hay than in the ration with orchard grass hay or alone, the increase falling on the fat and carbohydrates, 100.00 per cent. of the nitrogen-free extract being digested in both rations.

TABLE XXX.—Showing the Digestibility of Corn Meal when fed Alone and in Rations by Cows, Goats, and Pigs.

	Dry matter.	Ash.	Protein.	Fats. (Ether extract)	N-free extract.	Crude fiber.
Corn meal fed alone to goat	86.89	0.00	66.89	80.47	94.22	0.00
Corn meal fed in ration of 2.3 pounds orchard grass hay to 1 pound corn meal (dry matter basis) to cows*	84.6	....	58.3	91.9	87.1	0.00
Corn meal fed in rations of 2.36 and 1.83 pounds crimson clover hay to 1 pound meal to goats	92.35	45.98	58.6	97.65	100.00	18.23
Corn meal fed alone to pigs†	89.5	...	86.1	81.7	94.2	29.4

*N. Y. Experiment Station, 7th Annual Report, pp. 278–9.
†Maine Experiment Station, Report 1885–'6, p. 61.

XVI. DIGESTION OF CORN-AND-COB MEAL,

BY BLACK GOAT.

Date of experiment, April and May, 1893.
Daily ration: 900 grams fed, 800.4 grams eaten.
Total period, 20 days.
Collections, the last 6 days.
Analytical and other data for obtaining the coefficients of digestibility are given in Tables XXXI and XXXII.

The same corn as used in experiments 14 and 15 was ground without shelling and made a rather coarse meal showing small pieces

TABLE XXXI.—Showing Percentage Composition of Corn-and-Cob Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumin'ds (Alb N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Corn-and-cob meal	12.43	87.57	1.41	9.03	9.03	3.79	76.63	9.14
Waste, corn-and-cob meal	12.46	87.54	1.66	8.93	8.93	4.19	78.57	6.65
Solid excrement	65 08	34.92	7.59	14.79	12.19	2.71	51.66	23.25

TABLE XXXII.—Showing Nutrients Consumed and Excreted in Grams with Percentages

BULLETIN No. 97, PAGE 129.

CORRECTED

TABLE No. XXXII.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

BLACK GOAT.

	Total Amount.	Dry Matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25	Albumi'ds (Alb. N ×6.25)	Fat. (Ether extract.)	N-free Extract.	Crude fiber.
Corn-and-cob meal fed	5400.00	4728.8	66.68	427.01	427.01	179.22	3673.68	432.21
Waste, corn-and-cob meal	597.5	523.1	8.68	46.71	46.71	21.91	411.00	34.78
Total consumed	.....	4205.7	58.00	380.30	380.30	157.31	3262.68	397.43
Total solid excrement	2561.2	894.4	67.88	132.28	109.03	24.24	462.05	207.95
Total digested	.....	3311.3	.....	248.02	271.27	133.07	2800.63	189.48
Per cent. of corn-and-cob meal digested	.....	78.73	.....	65.21	71.33†	84.59	85.84	47.67
Consumed in corn of corn-and-cob meal	.....	3417.97	51.61	344.53	344.53	171.92	2789.06	60.84
Consumed in cobs of corn-and-cob meal	.....	787.73	6.39	35.77	35.77	.....	473.62	366.59
Digested from corn of corn-and-cob meal	.....	2969.87	.....	230.46	252.43	138.34	2627.85	22.18
Digest'd from cobs of corn-and-cob meal	.....	341.43	.....	7.56	18.84	.....	172.78	167.30
Per cent. digested from cobs of corn-and-cob meal	.....	43.34	.....	21.13	52.67	.....	36.48	49.70
Per cent digest'd from fine ground corn-cobs when fed to sheep with hay and N. P Linseed meal‡	.....	60.43	.....	21.80	.....	56.00	60.37	64.50

Nutritive ratio of corn-and-cob meal, 1 : 13, 2.

†See discussion, page 125, of real and apparent digestibility of albuminoids in trial with corn meal alone.

‡Mass. Ag. Expt. Station. Report of this experiment has reached us just in time to be included in this correction to the table. The increased digestibility of carbohydrates which seems to result from additions of nitrogenous by-fodders to coarse foods poor in nitrogen is brought out by comparison in last two lines of this table.

The coefficients of digestibility obtained in this trial compare very well with those of the Maine Station. As shown below, the Dent corn digested here by the goat, gives a little higher coefficients of digestibility than did the flint corn there as digested by a pig. This is true for all constituents determined except protein.

It is well known that the pig is able to extract more of the protein from its food than do ruminants; for examples, see comparisons with corn meal in Table XXX of this bulletin. The protein was digested well by the goat. Its digestibility was but 10.5 per cent. lower than that for the pig shown in the below comparison, while the per cent. is higher than that of corn meal digested by a cow, and very nearly equal that of corn meal digested by the companion goat in experiment 14. The low percentage of crude

*Maine Agricultural Experiment Station, Annual Reports for 1885-'86.

In Table XXX, are brought together for comparison the coeffi-

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without shelling and made a rather coarse meal showing small pieces

TABLE XXXI.—Showing Percentage Composition of Corn-and-Cob Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumi'ds (Alb N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Corn-and-cob meal	12.43	87.57	1.41	9.03	9.03	3.79	76.63	9.14
Waste, corn-and-cob meal	12.46	87.54	1.66	8.93	8.93	4.19	78.57	6.65
Solid excrement	65 08	34.92	7.59	14.79	12.19	2.71	51.66	23.25

TABLE XXXII.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

BLACK GOAT.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25	Albumi'ds (Alb. N ×6.25)	Fats. (Ether extract)	N free extract.	Crude fiber.
Corn-and-cob meal fed	5400.0	4728.8	66.68	427.01	427.01	179.22	3673.68	432.21
Waste, corn-and-cob meal	597.5	523.1	8.68	46.71	46.71	21.91	411.00	34.78
Total consumed	.....	4205.7	58.00	380.30	380.30	157.31	3212.68	397.43
Total solid excrement	2561.2	894.4	67.88	132.28	109.03	24.24	462.05	207.95
Total digested	.....	3311.3	.....	248.02	271.27	133.07	2750.63	189.48
Per cent. of corn-and-cob meal digested	.....	**78.73**	.....	**65.21**	***71.33**	**84.59**	**85.61**	**47.67**
Consumed in corn of corn-and-cob meal	.....	3417.97	47.14	309.07	309.07	127.85	2599.96	320.99
Consumed in cobs of corn-and-cob meal	.....	787.73	10.86	71.23	71.23	29.46	612.72	74.44
Digested from corn of corn-and-cob meal	.....	2969.87	.....	206.74	237.85	102.88	2449.68	117.76
Digested from cobs of corn-and-cob meal	.....	341.43	.....	41.28	33.42	30.19	300.95	72.10
Per cent. digest'd from cobs	.....	43.34	....	**57.95**	**46.92**	**100.**	**49.12**	**96.34**

Nutritive ratio of corn-and-cob meal, 1:13.19.

*See discussion, p. 125, of real and apparent digestibility of albuminoids in trial with corn meal alone.

of cobs and cracked kernels. After being fed in ration with clover hay, this meal was fed by itself. The goat gained some body weight during this period.

The coarse meal was digested very well. It fell behind the corn meal in every constituent digested except fat.

Corn-and-cob meal has been subjected to digestion once before in this country, the pig being the animal used.*

The coefficients of digestibility obtained in this trial compare very well with those of the Maine Station. As shown below, the Dent corn digested here by the goat, gives a little higher coefficients of digestibility than did the flint corn there as digested by a pig. This is true for all constituents determined except protein.

It is well known that the pig is able to extract more of the protein from its food than do ruminants; for examples, see comparisons with corn meal in Table XXX of this bulletin. The protein was digested well by the goat. Its digestibility was but 10.5 per cent. lower than that for the pig shown in the below comparison, while the per cent. is higher than that of corn meal digested by a cow, and very nearly equal that of corn meal digested by the companion goat in experiment 14. The low percentage of crude

*Maine Agricultural Experiment Station, Annual Reports for 1885-'86.

	Total dry matter.	Organic matter.	Protein (N×6.25)	Albumin'ids (N×6.25)	Fat. (Ether extract)	N free extract.	Crude fiber.
North Carolina Dent corn-and-cob meal	78.73	.....	65.21	71.33	84.59	85.61	47.67
Maine flint corn-and-cob meal	75.6	76.7	75.70	.....	82.0	83.6	28.5

fiber in the waste indicates that the goat may have selected pieces of cobs and eaten this part somewhat better than he ate the corn meal, in which case the coefficients given for cobs would be a trifle higher than that actually digested. It may possibly be also an error of sampling and not a difference of eating.

In calculating the digestibility of the cobs, the coefficients for the corn meal fed alone have been used except that for crude fiber. For that, the coefficient found (36.46) in the experiment on crimson clover hay and corn meal with the gray goat was used. These factors give a very favorable result for feeding corn-and-cob meal.

Shelling a sample 100 pounds of ear corn a yield of 81.5 pounds kernels, and 18.5 pounds of cobs was reached. The analyses show 12.68 per cent. of water in corn meal, and 12.43 per cent. in corn-and-cob meal. From these data there was found 11.35 per cent. of water in cobs, and 71.17 and 16.40 pounds of dry matter, respectively, in these products. The dry matter would be divided between corn and cobs as 71.17 to 16.40.

By feeding the cobs as corn-and-cob meal, 7.11 pounds of digestible dry matter was added to the 61.84 pounds digestible from the kernels. This is equivalent to saving 10.31 per cent. of the digestible food in 100 pounds of ear corn. Or, calculated on shelled corn, and assuming the cobs lost if shelled, it adds 9.84 pounds of digestible food in the cobs to the 75.88 pounds in 100 pounds of corn meal. This is an addition of 12.96 per cent. to the digestible dry matter in the corn meal.

XVII. DIGESTION OF RATION OF CRIMSON CLOVER HAY AND CORN-AND-COB MEAL,

BY BLACK AND GRAY GOATS.

Date of experiments, March and April, 1893.

Daily ration:

- Black goat: Fed 900 grams hay, 300 grams meal. Eaten 539.3 grams hay, 300 grams meal.
- Gray goat: Fed 900 grams hay, 300 grams meal. Eaten 405.98 grams hay, 300 grams meal.

Total period, 12 days for black, and 14 days for gray goat.

Collection period, the last 5 days for each animal.

Analytical and other data for obtaining the coefficients of digestibility are contained in Tables XXXIII and XXXIV.

The hay was fed in much larger amounts than eaten by the goats and was eaten by them in different proportions. This gives two quite distinct rations which have affected the percentages digested in a somewhat marked degree and as would be expected, though not at first glance appearing to harmonize with the results of other

TABLE XXXIII.—Showing Percentage Composition of Crimson Clover Hay, Corn-and-cob Meal, Waste, and Solid Excrement.

	Water.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumin'ds (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract	Crude fiber.
Crimson clover hay	12.33	87.67	8.20	16.41	13.70	2.40	44.59	28.40
Corn-and-cob meal	12.43	87.57	1.41	9.03	9.03	3.79	76.63	9.14
Waste, crimson clover hay, black goat	16.86	83.14	8.84	16.85	13.12	2.34	43.51	28.46
Waste, crimson clover hay, gray goat	11.81	88.19	8.66	19.93	16.37	2.87	46.39	22.15
Solid excrement, black goat	58.55	41.45	8.98	14.47	12.00	3.21	38.02	35.32
Solid excrement, gray goat	58.24	41.76	8.55	14.79	12.12	2.97	37.81	35.88

experiments on rations with variations in the same direction. The corn-and-cob meal, while containing a comparatively large amount of carbohydrates, is in itself a very easily digestible article, partly from its low content of crude fiber. The hay, on the contrary, while a good sample of hay, yet contains in relation to the meal much the larger proportion of crude fiber. This gives a variation quite different from that where the excess of carbohydrates in the wide ratio rations have contained large amounts of crude fiber. The digestibility of the protein in the wide ratio ration is still depressed a little below that of the narrower ration, while the high digestibility of the constituents of the meal united with the relatively large amount in the wide ratio ration eaten, yield slightly higher coefficients than are found in the narrower ration for all other constituents.

These rations were well digested, but fall behind the exceedingly easily digestible ration of corn meal and clover hay by from 6 to 10 per cent. of the different constituents. There were no very wide differences while there was a high degree of regularity in the excess of each of the coefficients except protein of the wide ratio ration over those of the narrow one. The constituents of the corn-and-cob meal except the protein, were digested about as well in the ration as when fed alone.

TABLE XXXIV.—Showing Nutrients Consumed and Excreted in Grams with Percentages Digested.

BLACK GOAT. RATION: CRIMSON CLOVER HAY AND CORN AND COB MEAL, 1.8:1.

	Total amount.	Dry matter.	DRY MATTER CONTAINS					
			Ash.	Protein (N×6.25)	Albumin'ids (Alb. N ×6.25)	Fats. (Ether extract)	N-free extract.	Crude fiber.
Crimson clover hay fed	4500.0	3945.2	323.51	647.41	540.49	94.68	1759.16	1120.44
Corn-and-cob meal fed	1500.0	1313.6	18.52	118.62	118.62	49.78	1006.61	120.06
Total fed	6000.0	5258.8	341.03	766.03	659.11	144.46	2765.77	1240.50
Waste, crimson clover hay	1803.3	1499.3	132.54	252.63	196.71	35.08	652.34	426.70
Total consumed	.....	3759.5	209.49	513.40	462.40	109.38	2113.43	813.80
Total solid excrement	3110.3	1289.1	115.80	186.50	154.69	41.38	490.12	455.31
Total digested	.....	2470.4	93.69	326.90	307.71	68.00	1623.31	358.49
Digested from crimson clover hay	.....	1494.7	113.47	269.36	210.19	25.79	736.59	356.58
Digested from corn-and-cob meal	....	975.7	.....	57.54	97.52	42.21	886.72	1.91
Per cent. of ration digested	.....	**65.71**	**44.72**	**63.67**	66.54 59.67	**62.17**	**76.81**	**44.05**
Per cent. of corn-and-cob meal digested	.....	**74.28**	.....	**48.51**	82.21 55.40	**84.79**	**88.09**	**1.59**

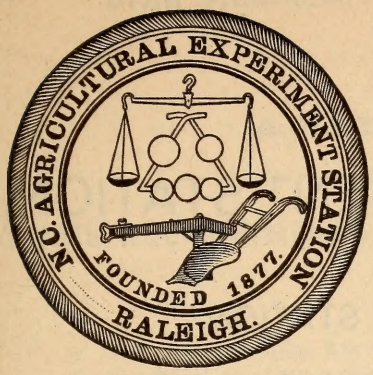
GRAY GOAT. RATION: CRIMSON CLOVER HAY AND CORN-AND-COB MEAL, 1.35:1.

Crimson clover hay fed	4500.0	3945.2	323.51	647.41	540.49	94.68	1759.16	1120.44
Corn-and-cob meal fed	1500.0	1313.6	18.52	118.62	118.62	49.78	1006.61	120.06
Total fed	6000.0	5258.8	342.03	766.03	659.11	144.46	2765.77	1240.50
Waste, crims'n clover hay	2470.1	2178.4	188.64	434.16	356.60	62.52	1010.56	482.51
Total consumed	.....	3080.4	153.39	331.87	302.51	81.94	1755.21	757.99
Total solid excrement	2185.2	912.5	78.02	134.96	110.60	27.10	345.02	327.41
Total digested	.....	2167.9	75.37	196.91	191.91	54.84	1410.19	430.58
Digested from crimson clover hay	.....	1079.7	80.14	145.50	112.43	13.92	498.19	327.90
Digested from corn-and-cob meal	.....	1088.2	.....	51.41	79.48	40.92	912.00	102.68
Per cent. of ration digest'd	.....	**70.37**	**49.13**	**59.33**	63.44 55.39	**66.92**	**80.34**	**56.81**
Per cent. of corn and-cob meal digested	.....	**82.84**	.....	**43.34**	67.00 *46.48	**82.20**	**90.60**	**85.52**
Mean per cent. of above two rations digested	.....	**68.04**	**46.93**	**61.50**	64.99 57.53	**64.55**	**78.58**	**50.43**
Mean per cent. of corn-and-cob meal digested in above rations	.....	**78.56**	.....	**45.93**	74.60 *50.94	**83.50**	**89.35**	**43.55**

Nutritive ratio of ration of 1 pound corn-and-cob meal to 1.8 pounds crimson clover hay, 1:6.58.

Nutritive ratio of ration of 1 pound corn-and cob meal to 1.35 pounds crimson clover hay, 1 to 10.04.

*See discussion (p. 126) of real and apparent digestibility of albuminoids in rations of corn meal and crimson clover hay.



March 1, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 98.

SOME LEGUMINOUS CROPS AND THEIR ECONOMIC VALUE,

INCLUDING

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II. THE CULTIVATION OF LEGUMINOUS PLANTS FOR FORAGE.
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RALEIGH, N. C.

SOME LEGUMINOUS CROPS AND THEIR ECONOMIC VALUE,

INCLUDING

I. LEGUMINES AS IMPROVERS OF THE SOIL.
II. THE CULTIVATION OF LEGUMINOUS PLANTS FOR FORAGE.
III. THE FUNGOUS AND INSECT ENEMIES OF LEGUMES.

BY GERALD McCARTHY, BOTANIST, AND F. E. EMERY, AGRICULTURIST.

Among the natural orders or families of plants, none hold a higher place in relation to human welfare than the *Leguminoseæ* or Pulse family. This family includes every variety of bean, pea, clover, medic, vetch, and many useful and poisonous drugs, besides a number of our finest ornamental and timber trees. The legumines were among the first vegetables cultivated by mankind, and have ever been among those most esteemed. Nearly all this family of plants have a peculiarly shaped, butterfly-like flower, and the seeds are enclosed in pods which are often arranged in one-seeded joints. Both the stems and the seeds of all the legumines are very rich in albuminoids—the food which goes to form the muscular or lean-meat portion of flesh, and are therefore especially valuable for young and growing stock and for working animals.

In North Carolina, the most valuable and generally used forage and fertilizing plants of this family are the true clovers, medics, Japan clover, vetches, cow-peas, and Japan peas. Many other species lately introduced from Japan, Russia, India, and elsewhere, are under trial at the N. C. Experiment Station, some of which are very promising and will be referred to later on.

The great value of the legumines as forage plants lies in their rich store of albuminoids. But albuminoids are only a highly organized form of nitrogen which as nitrates is a necessary constituent of all fertile soils. It has been long known to observant farmers that a crop of grain following a crop of legumines is always better than a crop on equally good land following a non-leguminous crop. It is now known that most or all of this family of plants have a property possessed by no other family of plants—that of harboring in their roots a species or class of yet unnamed microbes which fix the free-nitrogen of the air which is then absorbed and utilized by the plant in its growth and fruition. We can, therefore, by stimulating a luxuriant growth of legumines obtain at slight expense the nitrogen required by other nitrogen-consuming crops. Nitrogen in the form of nitrate of soda, dried blood, cotton-seed meal, etc., is one of the

most expensive fertilizers, costing about 18 cents per pound. Experiments and chemical analyses at several experiment stations have shown that one acre of lucerne may produce nitrates worth as fertilizer forty-three dollars; one acre of cow-peas twenty-five dollars; one acre of red clover fifteen dollars. This is in addition to their food or feeding value, deducting about one-fifth for the amount fixed in the body of the animal. We see, then, that both as a food for animals and as an improver of the soil, legumines are more valuable than other forage plants, and should therefore form a portion of the rotation employed on all farms.

Some Legumines Tested by the Station.

In the spring of 1891, 108 plats (each 4 x 17 feet) with 2-foot spaces between were laid off on a spot of moist, clayey ground on the Experiment Farm. Another field on a higher and drier soil was laid off into plats 4 x 90 feet with 3-foot spaces between. On these plats unmixed sowings of all the forage plants mentioned in this Bulletin were sown. The smaller or lowland plats were under the control of the Botanist of the Station. Those on the upland were in charge of the Agriculturist.

The best of the legumines described and tested will be further grown during 1894, and sufficient seed saved for distribution throughout the State to responsible parties for testing. Persons applying for them will be required to send sufficient postage for transmission through the mails.

The general result of the two years test is as follows:

Lucerne—*Medicago sativa.*—Lucerne is a deep rooting, perennial, bushy legumine, growing from 18 to 24 inches high. Stems become woody soon after flowering Flowers purple or blue, pods twisted, one seeded. Seeds resemble red clover seed. Hardy everywhere.



Fig. 1. Lucerne.

Lucerne grows best upon a deep, loose, dry limestone soil, but when lime or marl can be artificially supplied does excellently on sandy loam. Our plats were upon a stiff red-clay soil and the lowland plat rather too moist. The roots could not penetrate deeply, and upon such soil the growth was necessarily slow and the plant was unable to withstand the intrusion of crab and Bermuda grasses and weeds. On this soil lucerne is not as satisfactory as hybrid medic or "sand lucerne." Where it succeeds, lucerne is the best of all meadow plants, but cannot be grazed. Where the soil is rich and free from weed seeds, lucerne may be sown broadcast, using 25 pounds of seed per acre. On less favorable soil it should be drilled two feet apart, using 12 to 18 pounds of seed per acre. Cultivate for the first year. The best time to sow is during September, or for the western

portion of the State about August 15. Seed should be covered very lightly.

Hybrid Medic or Sand Lucerne—*Medicago media.*—Hybrid medic resembles lucerne, but is of smaller growth. Flowers yellow and blue. Perennial, deep rooting. Supposed to be a hybrid between *Medicago sativa* and *M. falcata.*

The hybrid medic plat was during the whole two years test superior to the adjoining lucerne plat. It is less delicate and more able to resist the intrusion of weeds. It does not, however, give more than one-half the herbage lucerne does on soil adapted to the latter. Hybrid medic may be sown broadcast from August 15 to October 1, using 18 to 20 pounds of seed per acre.

None-such, or Black Medic — *Medicago lupulina.* — None-such or hop-trefoil is a low-growing annual medic, resembling Japan clover in its growth. Flowers yellow, pods black when ripe, seeds resemble lucerne. Hop-trefoil shows rather less promise than Japan clover, but is more hardy and may be used where the other does not stand the winter. It seeds abundantly and will reseed the ground each year if not too closely cropped. Seed should be sown broadcast about 20 pounds per acre and should always be sown in spring. May be mixed with grasses in any ratio.

Sanfoin—*Onobrychis sativa.*—Sanfoin is a very deeply rooting, long-lived perennial legumine. Flowers rose-colored. Pods one-seeded. Seeds large, kidney-shaped. Stems 12 to 18 inches high. At least a half-dozen attempts have been made at this Station to get sanfoin to grow and all have failed. The plant requires a dry, deep, loose, limy soil. In Europe it thrives on soils white with chalk. With us it seems to have no value.

Sulla—*Hedysarum coronarium.*—Sulla is a biennial legumine resembling the common vetch, but has scarlet flowers and the pod is several jointed.

Sulla is much esteemed in Southern Europe, where it thrives on soil too sandy to bring good clover. In this country it has in several States given excellent results upon pine-barren soil. On our stiff red clay it failed utterly. This plant is probably inferior to the cow-pea and soy pea for fair average soil, but may with advantage be tried on the sandy lands of the Eastern district. Sow seed broadcast in early spring, about 25 pounds per acre.

Seradella—*Ornithopus sativus.*—Seradella is also an annual legumine, growing taller than sulla, but of about the same value and suitable for similar soil. With us the plant made a feeble spring growth and soon became choked out by weeds. This plant has also given good results on pine-barren soil, and may be advantageously tried upon such soils in this State. Sow seed broadcast in early spring, using 20 pounds per acre.

Kidney Vetch—*Anthyllis vulneraria.*—The kidney vetch is a biennial with simple strap-shaped leaves the first year and compound vetch-like leaves the second year. Flowers yellow. This plant

requires a strong limestone soil. With us it made a feeble growth in spring and was smothered out by crab and Bermuda grasses in late summer. It has no value here.

JAPAN CLOVER—*Lespedeza striata.*—Japan clover is a low-growing annual legumine which reseeds itself each year and holds the ground against all other plants. Flowers very small, blue.



Fig. 2. Japan Clover.

Japan clover seems to prefer hard, dry, clay soil. On better soil it is less able to withstand wild grasses and weeds. On dry soil it grows only two or three inches high, but upon richer soil it grows from twelve to sixteen inches high. But upon rich soils better plants may be grown. Our plats sown in spring seemed almost a failure at first, but when the weather became warm it pushed forward rapidly and took complete possession of the plats. The second year it was nearly run out of the rich moist plat by white clover, but on a dryer plat still holds its ground. The seed should be sown only in late spring, broadcast, 12 to 15 pounds per acre.

HAGY—*Lespedeza bi-color—var. intermedia*—Hagy is a perennial species of lespedeza, bushy, resembling lucerne. Much esteemed as a meadow plant in Japan. Our seed germinated feebly and the plants soon died out. This plant has promise, and will be tried further.

SOFT TICK SEED, OR BEGGAR WEED—*Desmodium molle.*—Beggar weed is an annual, tall growing, bushy legumine of the tick seed tribe. Flowers purple; pods many jointed, the joints being prickly, and hence are hard to get rid of when they get into the wool of sheep. This plant grows spontaneously in the piney woods, and in Florida is highly esteemed. It becomes woody even before it flowers, and as a forage plant has scarcely more value than willow or poplar sprouts. Not worth cultivating.

YELLOW LUPINE—*Lupinus luteus.*—The yellow lupine is an annual deeply rooting legumine with yellow flowers, pods white with yellow hairs, stems six to twelve inches high. This plant is very pretty when in flower and is still cultivated in many gardens. The roots run deep and hence it is a good plant for sandy soil. The herbage is bitter and not liked by stock, and the plant is useful only for improving the land where the cow-pea does not do well. Seed should be sown broadcast in spring, about 30 pounds per acre.

COMMON VETCH—*Vicia sativa.*—The common vetch is an annual legumine with dense foliage and purple flowers. There are two cultivated varieties—the winter and spring vetches. The winter vetch is very hardy and for moist land has no superior for a winter crop. The spring vetch is much hardier than the cow-pea and may be

sown much earlier. With us it gave excellent results and was fit to cut for hay by June 10, in time to plant a crop of ensilage corn. Sow broadcast 30 pounds per acre.



Fig. 3. Common Vetch.

WOOLLY VETCH—*Vicia villosa.*—Woolly vetch is an annual, much resembling the common vetch, but grows two and one-half to three feet high. Flowers dark purple.

This vetch proved inferior to the common vetch in every way. The leaves and stems are very woolly and seem to be distasteful to stock.

HAIRY VETCHLING—*Lathyrus hirsutus.*—The hairy vetchling is an annual twining legumine, growing three to five feet high when supported, when not supported it lies flat on the ground. Flowers purple. In growth and foliage resembles the vetches.

This plant seems tender and does not grow rapidly until warm weather, and fails to hold the ground against crab and Bermuda grasses. It does best on good upland soil, but is far below the cow-pea and other good annual forage plants. Like most of the lathyrus kind, this plant conains a bitter and poisonous principle, which makes its use undesirable even if we had not better plants.

IMPROVED FLAT PEA—*Lathyrus sylvestris, wagneri.*—The "flat pea" is a perennial climbing legumine with purple flowers. Resembles the vetch in its herbage and growth. Native of Europe, where it grows wild in the woods and is considered poisonous. The originator of this variety claims to have bred out the poisonous principle. The seed is verv difficult and slow to germinate and seems to have little vitality. The plants are at first very feeble, and grow so slowly that it requires three or more years to establish them. Our first sowing of seed produced but a few feeble plants which soon died. Seed was then sown indoors, and a small number of plants obtained, which were grown in flower pots and transplanted to the field in fall. These all lived but have never flowered or produced much herbage. This plant does not promise much for soils like ours.

FALSE OR BASTARD VETCH—*Phaca Bœtica.*—This plant is a perennial, bushy, woolly-leaved legumine, much esteemed in Algeria and Southern France as a fertilizing plant. Flowers red. Seeds large, resembling those of the lupine. Our plants grew very slowly, failed to flower and all died during summer. Seems to have no value here.

GOOBER PEA—*Voandzea subterranea.*—This plant is an annual low growing legumine with small yellowish flowers and seeds contained

in large round one-seeded pods which are buried and ripened in the ground like pea-nuts. This is not the true pea or ground-nut which is also sometimes called goober pea. The goober pea is of smaller growth than the common pea-nut and is much less prolific of seed, hence, has no economic value for us.



Fig. 4. Alsike Clover.

ALSIKE CLOVER—*Trifolium hybridum.*—Alsike clover is a short-lived perennial supposed to be a hybrid between red and white clovers. It grows 12 to 16 inches high and has pinkish flowers. The seeds are very small, greenish yellow. Roots fibrous and shallow. This is the best of the clover tribe for moist land. Our plat did well and still holds the ground in part though beset with Bermuda grass. Alsike is a better plant than red clover to sow with timothy grass. It should never be sown alone or form more than one-fourth the herbage, as where too thick it rots at the base. In a mixture with timothy, orchard, or other grasses, sow three or four pounds of seed per acre.

COMMON WHITE CLOVER—*Trofolium repens.*—White clover is a perennial creeping legumine with white flowers and small seeds.



Fig. 5. White Clover.

White clover is a strong perennial, and does well on any kind of soil that is moist and fertile. Our plats did excellently, and after covering their own ground invaded the neighboring plats and ran out the red clover. This clover should be sown in all pasture mixtures on low land. In a mixture with grass seeds, sow three to five pounds of seed per acre.

GIANT BROAD-LEAVED WHITE CLOVER—*Trifolium repens, var. latus.*—This is an improved variety of the common white clover. Our seed came from Fratelli Ingegnoli, Milan, Italy. The plant is much more robust and has larger leaves than the common species, but produces very little seed. If it seeded more freely it would undoubtedly supersede the common white clover, as it gives more than twice as much herbage and seems as hardy as the other.

COMMON RED CLOVER—*Trifolium pratense.*—Red clover is a biennial deep-rooting legumine esteemed above all other forage plants. Flowers in pinkish oval heads. Pods one-seeded.



Fig. 6. Red Clover.

Red clover succeeded well on all our plats and held the ground against all intruders except Bermuda grass for the first two years. It then gave way to white clover in spring and Bermuda grass in summer. It rarely happens that red clover is profitable beyond the second year of its growth. It reseeds itself fairly where the ground is loose and moist, but this is seldom the case, as clover is generally sown on clay soil. For a good stand of red clover use 20 to 25 pounds seed. Sow in fall.

MAMMOTH OR PEA-VINE CLOVER—*Trifolium pratense perenne.*—Pea-vine clover is a short-lived perennial variety of the common red clover. Its roots are more fibrous and its herbage more hairy than the common red clover. Its stems are longer and weaker. Flowers later than red clover. On our plats it grew more luxuriantly than the common species and remained longer, but is now giving way to Bermuda grass. This is a better plant than common red clover to sow with grasses, as it remains longer and the grasses hold its weak stems up. It does better than red clover on light soil. Seed about the same as red clover.



Fig. 7. Pea-vine Clover.

ZIG-ZAG CLOVER—*Trifolium medium.*—This species of clover is scarcely distinct from common red clover. In every particular this is inferior to both red and pea-vine clover, and has therefore no value where the others can be grown.

CRIMSON CLOVER—*Trifolium incarnatum.*—Crimson, sometimes called German, Italian, and Annual clover, is an annual species of the genus Trifolium, to which all the true clovers belong. It is very hardy and thrives upon soil too sandy for any other species of clover. It does not do well upon heavy or moist clay soil. Its chief value is for winter occupancy of the ground in latitudes where frost rarely penetrates the ground very deeply. It can be sown in early spring also, but should not be attempted on heavy or wet land. Seed required is about 15 pounds per acre. Crimson clover makes a hay nearly as good as red clover and cures more easily.

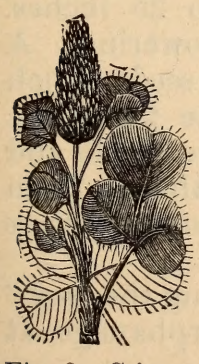


Fig. 8. Crimson Clover.

COW-PEA—*Dolichos catiang* × *sinensis.*—All the varieties here named were sown May 20 and received the same care.

The "Unknown" Pea.—Seeds light brown, oblique. This variety proved to be the most vigorous grower and greatest yielder of both herbage and seeds of all the varieties tested. Pods ripen very late.

The "Wonderful" Pea.—This is the "Unknown" under a new name.

The Whippoorwill Pea.—Seeds flatish, brown, spotted. A moderate yielder of herbage, but good yielder of seeds. Pods ripen earliest of all.

The Black Pea.—Seeds black. Grew finely, and in yield of herbage and seed was second only to the "Unknown."

The Stewart Pea.—Seeds blotched brown and white. Grew fairly, herbage rather scant. Pods ripened after Whippoorwill.

The Lady Pea.—Seed white with brown eye. Grew fairly, but herbage rather scant. Ripened seed about the same time as the Stewart. Yielded a good crop of seed.

The Conch Pea.—Seeds pure white and very small. Grew well, running extensively—stems 12 to 15 feet lying on ground. Leafstalks only four or five inches high, but leaves are so abundant as to completely shade the ground. Did not flower or produce seed.

The Red Ripper Pea.—Seeds angular, red. A strong, vigorous grower, in production of herbage and seed ranking next to the Speckled Pea.

Capehart's Red Pea.—Seed larger than Red Ripper pea. This seems to be a strain of the Red Ripper. Has larger seeds and seems to be rather more prolific—herbage about the same.

The Speckled Pea.—Seed flat, gray and spotted. A rank, vigorous grower, equalling the Black Pea in amount of herbage and seed, but ripens its pods earlier than the Black Pea.

JAPANESE PEAS—*Glycine hispida.*—The Japanese or Mongolian pea is more commonly called "soja" and "soy" bean, but it is not a bean.



Fig. 9. Japanese or Soy Pea.

Recently there have been introduced several new varieties of this pea. All the following varieties were sown May 20 and received the same treatment:

The common Soja Bean or Soy Pea.—Seed round, yellow. A vigorous growing, hairy, bushy plant attaining a height of 20 to 25 inches. Stems become woody soon after flowering. A very prolific bearer of round yellow seeds, which are sometimes used as a substitute for coffee. The peas, when properly cooked, are edible and palatable. The edible qualities of the soy bean are *so highly esteemed in Japan that it is there rarely fed to stock.*

The following directions for cooking the "soy" pea are given by Dr. J. H. Mills, of the Baptist Orphanage at Thomasville, N. C.:

Soak the peas till the skins come off. Then stir the peas in the water until the skins rise to the surface and skim them off. Boil the peas with bacon until soft. Add pepper and butter to suit and serve hot. If the peas are green the preliminary soaking may be omitted. This makes a most palatable dish, well liked by children.

Japan Pea No. 9.—A vigorous, bushy plant resembling the "soy," but smoother and has larger dark-colored seeds. This is the best of the new varieties.

Japanese Pea No. 7.—A small, slender, bushy plant bearing a fair crop of small cream-colored peas—inferior to the soy and No. 9.

JAPANESE BEANS—*Phaseolus radiatus—Japanese Bean No. 5.*—A low and slender-growing plant bearing numerous pods well filled with a small red bean which makes excellent soup.

Japanese Bean No. 6.—A plant scarcely distinguished from No. 5 and of about the same value. Both these beans are for table use only and not for forage.

LEGUMINES AS IMPROVERS OF THE SOIL.

By GERALD McCARTHY, Botanist.

From time immemorial, the importance of plowing under green clover has been understood and practiced by intelligent farmers. Long before science furnished the explanation, experience had proved that a crop of grain or any non-leguminous plant following a crop of clover, peas or vetches plowed under yielded far more than a similar crop following a non-leguminous crop. Even the roots and stubble of a leguminous crop proved almost as valuable as a good coating of ordinary stable manure. The explanation of this fact as furnished by science is that the legumines are in some way, not yet fully understood, specially adapted for harboring in their roots one or more species of bacteria which absorb and fix the free-nitrogen of the air and give this to the host plant. If any one will go into a field—a poor or sandy field is best—and carefully dig or pull up a vigorous plant of the cow-pea, soy pea, or vetch, he will find the roots more or less thickly covered with small wart-like nodules. These nodules are the dwelling places of the nitrate-forming bacteria. Experiments at this and many other experiment stations have shown that leguminous plants can grow in soil absolutely devoid of nitrogen, provided the other necessary elements are supplied. For most soils, potash and phosphoric acid are all that need be supplied. Hence, if we supply sufficient potash and phosphoric acid to ensure a luxuriant growth of any legumine, we can draw upon the free-nitrogen of the atmosphere for the nitrates. Experiments have shown that one acre of lucerne may furnish us with forty-three dollars worth of nitrogen; one acre of red clover fifteen dollars worth; one acre of cow-pea vines twenty-five dollars worth.

Besides this nitrogen, which is worth, if purchased in commercial fertilizer, 18 cents per pound, these plants will furnish the soil with vegetable humus. Humus plays a very important but not always appreciated part in making a fertile soil. When the bare soil is exposed to a very hot sun as is the case in summer all through the cotton belt, it tends to become excessively hot, insomuch that the tender roots of growing plants are liable to become scorched or killed. Such soils, too, which become excessively heated during the day give off the heat as rapidly by radiation at night. Even if the heat is not sufficient to scorch the roots, the radiation causes such a great difference between the maximum and minimum daily temperature surrounding the roots that more or less injury to the plant follows.

Humus has a strong attraction for water and holds the moisture of showers and dews with considerable tenacity. When the exposed soil tends to become excessively hot, a large part of the heat is absorbed in vaporizing the moisture in the humus, and hence there is less danger of scorching the roots. Humus, also, in much the same way holds soluble fertilizers, which without this restraining action would be washed away in drainage or carried below the reach of cultivated plants. Humus also harbors and nourishes the organic ferments, to whose activity the conversion of ammonia and nitrites into assimilable nitrates is due. Humus in the soil, in short, acts in much the same way as does the fly-wheel of a steam-engine; it takes up and holds for a time the force which would otherwise have gone to waste. Besides increasing the store of nitrogen in the soil, growing legumines, like other plants, prevent the loss by leaching of soluble nitrates already in the soil. If hardy legumines, like crimson clover and winter vetch, are sown between rows of corn or cotton, or other cultivated crops, when these are cultivated for the last time, or "laid by," the legumines will take possession of the land when the summer crop is removed, and will everywhere south of the 35th parallel continue to grow during the winter months, thus preventing the leaching away of the nitrates already in the soil and adding new nitrogen from the atmosphere.

When legumines are grown for improving the land they m a be plowed under when pods are ripe, and then there will be no danger of the heavy green foliage souring the land. But a more rational and economical way to utilize the crop is to remove it as hay and feed to stock. The resulting manure should be carefully saved and put upon the land. This is by far the best plan, since the amount of nitrogen that a luxuriant growth of pea-vines, clover or vetches may supply to the soil is more than the succeeding crop is likely to need, and the surplus is liable to be lost by leaching away in drainage or percolating into the lower layers of the soil below the roots of most cultivated plants. In an experiment with lucerne at the New Jersey Station in 1887, one acre of this plant yielded 253 pounds of nitrogen, worth as commercial fertilizer 17 cents per pound, or about $43. One acre of cow-pea vines have contained nitrogen to the value of over $25. This is too much nitrogen to supply to the soil at one time, especially late in the season when vegetable growth is slow or ceases altogether. The feeding value of one ton of lucerne hay is about $17; that of one ton of pea-vine hay about $16. This value is wholly lost when the hay or fresh herbage is used directly as manure. When the hay or herbage is fed, and the manure produced by the animals is carefully saved, the feeding value plus four-fifths of the original fertilizing value can be recovered.

It may happen that a farmer who has a field of legumines has no stock to consume the herbage. Shall he plow under the herbage in the fall, or allow it to lie on the ground during winter? The answer must be, plow it under in the fall by all means. When left exposed

upon the surface the herbage undergoes a more or less complete decomposition during the winter months, and a large part of the nitrogen escapes into the atmosphere as ammonia or free-nitrogen gas, or is washed away by surface water. If plowed under, and a crop of some nitrogen-consuming plant, such as rye, wheat, buckwheat, rape, or mustard, is then sown upon the land, most of the soluble nitrates will be fixed and held fast by these crops. The Alabama Station in 1889–'90 made analyses of cow-pea vines taken from the same field at different dates during the fall and winter, with the following result:

Green vines collected in October contained 2.62 per cent. of nitrogen.
Dry vines collected in December contained 0.81 per cent. of nitrogen.
Dry vines collected in January contained 0.66 per cent. of nitrogen.

From these analyses that station concluded that "it is evident that when pea-vines are allowed to lie exposed on the soil much of the nitrogen collected is lost." Another reason for not allowing the dead herbage to lie upon the surface during the winter is that the spores of noxious fungi and eggs of noxious insects which infest the plant will be thus assisted to propagate their kind until eventually the further growth of the legumine becomes impossible.

THE CULTIVATION OF LEGUMINOUS PLANTS FOR FORAGE.

By F. E. EMERY, Agriculturist.

Leguminous plants serve a two-fold use in farm practice. They bring up large amounts of mineral food from the subsoil and store it in roots and stems, where it can be easily turned to account along with the nitrogen gathered and stored at the same time by the action of these plants with micro-organisms in the soil. Their value to the soil when plowed in is great, but if the plants can be fed to thrifty stock, and the carefully preserved excrement returned to the soil with stubble and roots, more profit by far should be realized from these crops than when the whole is applied directly to the soil.

For forage the legumines are used, first, for pasture and hay; second, for soiling and silage. They are put in this way as progressive steps in farm economy with increasing values of land and necessity for more carefully counting cost and returns to be derived therefrom.

The most frequently met pasture plants of this group are white and red clovers and Japan clovers. These bear grazing very well and yield abundantly under favorable conditions. White clover lives a longer time and is doubtless the best pasture clover. With Kentucky blue grass and Bermuda grass it yields in Eastern and Central North Carolina almost an ideal pasturage. Red clover can be counted on for only two years, but its decaying roots are of great advantage to the grasses with which it grows. If only partially grazed and seed is allowed to form this may last indefinitely.

Japan clover grows only in warm weather, and takes precedence to the exclusion of all competitors for space where conditions are suited and a foothold is gained. For this reason it is disliked by some thoughtful farmers, who would rather graze stock on some more socially inclined plants which have a season to lead in growth, and thus furnish a good "bite" to grazing animals nearly the whole year. Black medic (*Medicago lupulina*) has some qualities which indicate it may be as good a pasture clover as Japan clover and be more easily and widely spread.

Burr clover, *Medicago denticulata*, especially in the eastern part of this State is a valuable annual pasture plant. Crimson or annual clover may also be counted one of the grazing clovers of value. There are several native vetches in North Carolina, too, which deserve mention here, though on some ranges they are seldom found in the haunts of stock, since their attractiveness leads to their extermination.

The cow-pea is perhaps grazed more often in some parts of this State than any clover except Japan. A common custom is to sow some peas late and count on them to support the stock, or a part of it, until far into the winter. The foliage, rather soft stems, and long pods in various stages of growth are very nutritious and keep stock looking well during the mild weather of late autumn and early winter.

For hay, soiling and silage crops, the same plants may be used almost interchangeably. What is good for one of these uses is good for the others, but for convenience in curing some are preferable to others for hay. The most common legumines thus used are the cow-pea, crimson, red, and alsike clovers, lucerne, vetch and soy bean. These contain comparatively large amounts of albuminoids, which are easily digested when the crops are cured in good condition. They are all palatable and sought for by stock. They can be fed green—the soiling system; or made into hay, or ensiloed.

For Green Forage.

For feeding green, the crop should be convenient to the place where it is fed. Enough should be cut each day for the succeeding day's feed and allowed to wilt, or if desired it can be fed freshly cut, though smaller quantities should then be allowed because of danger from hoove, hoose, or bloat. For this purpose the crops may be first used some time before bloom, but unless it is specially needed, or there is some special reason, to begin cutting near the period of bloom will yield the greater crop though the soiling season on the crop will be shortened. The earlier cutting increases the value of the second cutting.

For Hay and Silage.

What is true of the development of these crops for soiling is equally true for hay or silage, except that for these uses fewer cuttings are desired, and the most digestible food possible to obtain for cutting is desired. The earlier the crop is cut the sooner the roots can start on the second one, or the sooner the ground will be cleared for another crop. Cutting as early as is consistent with the use to which the crop is to be put, also withdraws it from danger of damage by insects or other causes. Professor A. J. Cook, in Vol. I of Beal's Grasses of North America, enumerates upward of seventy species of insects which infest clover at some time during its life or the seed or hay obtained from it. Many of these live mostly on other plants, but some are to be feared and guarded against at every turn. The danger from insect depredators is more or less general, and few, if any, crops are free from them, hence the earliest period at which they are ready for harvest is probably the best time to harvest, and when properly cured and stored they should be used or sold as soon as they can be profitably disposed of. For hay, leguminous plants should always be cut before the pods are full grown, for in the

majority of cases the weevil insect lays her eggs in the growing pod in the field.

The cow-pea and soy bean will give better satisfaction for soiling or silage than for hay, unless sown broadcast where a considerable amount of crab grass will grow and separate and lighten up the broad leaves of these legumines enough to enable them to be cured as very good hay. Without something to lighten up these plants, the leaves are very hard to cure and much damage is done the hay by lack of sufficient airing.

A fairly satisfactory way to cure pea vines is to cut in the afternoon when there is a promise of fair weather, and let the pea vines lie and wilt until next day after the dew is off. The leaves will then be somewhat tough and the vines can be put up in moderate stacks without losing much foliage. The stacks should be as small as convenient to make, and from seven to nine feet high. These may stand until the vines are thoroughly cured, when they should be brought together and housed early in the morning or on a cloudy day, without rain, when the hay is tough enough to bear moving without loss of leaves.

To make hay of the clovers and other legumines and not lose the leaves and flowers is an accomplishment of which any farmer may well be proud. It requires special manual skill and a fine judgment as to when and how to handle the hay and how much it shall be cured. A page from Beal's Grasses of North America (p. 294) gives a clear view on this point: "It will be seen that it is by no means an easy matter to select the best time for cutting or the best process of curing grasses and clovers, or to tell just how much it is safe to rely on chemical analysis to help determine these questions; and when we come to the test of feeding, the difficulties are still increased on account of a changing climate, differences in the animals selected, and other things only thought of by men who have carefully experimented in feeding domestic animals. Partially cured hay may be pressed into very solid bales, and not be injured by heating. It keeps much like *ensilage* in a *silo*. If the hay in the cocks is too damp, before drawing it should be opened an hour or two. No fixed rule can be laid down to guide the farmer. Remember that dew and rain wash out much of the best portion of grass after it has been cured, or partially cured. A few minutes with an expert will show a beginner how to put hay into neat cocks of 75 to 200 pounds or more each. The hay at the top should spread and hang down the sides to help carry off rain, should any occur."

General W. G. LeDuc, formerly United States Commissioner of Agriculture, has the following on this topic: "There is an art in cocking the clover hay so that it will shed rain, and the best haymakers in this locality claim to have acquired the difficult art of thatching the clover cocks by dexterity in handling the fork and laying the hay. They insist on taking up small forkfuls of the windrow, placing one on top of another until they have a miniature

cock, then taking it up on a four-tined fork* and turning it skillfully so that the center of the forkful comes down, inverted upon the center of the forming cock. The cocks must be small and tall—such as will stand securely until the sunshine of the morrow."

Whoever can acquire this haymaking skill and practice it, need seldom be obliged to feed poorly cured or damaged hay. The best legumines for haymaking are those which yield their crop at the best climatic period in which to make the hay. Also those of which the foliage is of a suitable character or can be easily controlled. These are the clovers, medicagos, vetches, etc. The broader leaved plants are less adapted to hay making, though they can be cured into good hay.

For Soiling.

For soiling, those plants like lucerne which yield three to five cuttings per season are most desirable, as this quality obviates the necessity of so much plowing and preparation for succession crops.

Crops for silage should yield the maximum amount of forage at one time, and be prepared for harvest at a time when all other farm work is slack. Fortunately, two very valuable legumines meet these requirements and can be brought in readiness for harvest with our great cereal crop, corn. That these are not so well suited for hay as some others is no drawback for either soiling or silage, for which both plants are specially well fitted. The cow-pea grows luxuriantly in the corn-field, and the combination of corn with the legumine is advantageous in giving a greater yield from the same area and in the character of the cattle food produced by the combination. Soy beans grow upright and may be planted alternately with corn in the same row and cut at the same time with it. In order that the corn may be cultivated, and to have cow-pea vines in readiness to cut with corn, they should not be planted sooner than one month after the corn, and perhaps six weeks or two months would be better, especially if a late growing corn or early variety of pea is planted.

Preparation of the Soil and Fertilizers for Legumines.

This need differ in nowise from the proper preparation of a seed bed for other crops which are to be sown broadcast or planted in rows. The bed should be fine and smooth and the smaller seed covered lightly in the fresh moist earth as freshly prepared, preferably just after a rain than before. The larger seeds, if drilled or planted in hills, should be put into moist earth and this compacted a little over them in order that sufficient moisture may be retained around the seed to insure its prompt and successful germination.

The soil must be moderately rich in humus, as well as in all the essential elements of plant food, in order that a luxuriant growth may be insured. When the soil is thus supplied, then additions of potash and phosphoric acid are to be made to increase the yield with the least expense.

*A three-tined fork is much better and it should have a rather short handle. F. E. E.

THE FUNGOUS AND INSECT ENEMIES OF LEGUMINES.

By GERALD McCARTHY, Botanist and Entomologist.

A. Fungous Enemies.

Leguminous forage plants are not especially infested by fungous parasites where the soil and climate is favorable for such plants. The cow-pea is more or less damaged by several species of leaf rusts or blights. Among these probably the worst is *Septoria Dolichi, B. and C.*—a fungus closely related to the shot-hole fungus of the stone fruits. Several species of the genus *Uromyces* attack the leaves, and a leaf rust or blight similar to the rust of the strawberry is also rather prevalent. The pods when nearly full grown are occasionally attacked by a species of *Gleosporium,* causing the disease called anthracnose.

Lucerne is attacked also by this or a closely related fungus, as are also the clovers. The latter are especially infested by several species of leaf rusts and by a species of *Erysiphe* closely related to the mildew of grasses. Against these fungous pests, fungicides are of little use, as the foliage of the host plants is extremely tender as regards fungicidal chemicals. Clean fields and the disuse of stable manure, which is likely to harbor the spores of the fungi, are of the first importance. Drainage and stimulating fertilizer are next, and this is about all that can be profitably attempted.

B. Non-fungous Plant Parasites.

The only phanerogamic parasite of any importance is the notorious pest Dodder—*Cuscuta trifolii and C. Epythium.* Dodder is a yellow or reddish string-like, leafless, twining plant which often forms a network of its thread-like stems covering several square yards of space. It sends out suckers from every part of its stems which penetrate the stems of the host-plant and suck out the sap of the latter. Dodder is propagated by seeds in the usual manner, but the plant possesses no chlorophyl—the green coloring matter of plants through whose influence the plant is able to decompose the gases of the atmosphere and build their elements into its own structure. Unless the young dodder plant finds a host upon which it can fasten itself it dies of starvation very soon after germinating. When it finds such a host, it loses its connection with the soil and thereafter lives exclusively upon and at the expense of its host-plant.

Remedy: Purchase only clean dodder-free seed. Uncleaned or low grade clover and lucerne seed nearly always contains the seeds

of dodder. If dodder does appear in the field it should be promptly cut, carried away and burned before it has time to mature its seeds.

There is in Europe a very widespread disease of clover popularly known as "clover sickness," which seems to be as yet absent from this continent, or present in limited areas. Scientists are not satisfied as to the cause of clover sickness—some considering it the result of exhausting those elements of the soil which clover especially requires, others believe it is caused by the too great multiplication of bacteria, which may or may not be the identical microbes which enable these plants to draw upon the nitrogen of the atmosphere. These microbes may act upon the clover organism as certain classes of poisons do on the animal body—in small doses they act as stimulants, increasing assimilation, but in larger doses they benumb or destroy the life of the body. The only trustworthy remedy for clover sickness is rotation of crops, so that clover will not come again upon a "sick" field for four or five years. Lupines, vetches, peas and beans and other legumines will grow upon clover-sick land.

C. Insect Enemies.

Of the many insects which damage leguminous forage plants in this State, probably the worst are in their order of importance the pea and bean weevils, *Bruchus pisi* and *B. fabæ;* the clover seed midge, *Cecidomyia leguminicola;* the clover root borer, *Hylastes trifolii*, and the clover hay worm, *Asopia costalis.*

The Pea Weevil, *Bruchus pisi*, is the larger of the two common weevils. It is one-fifth inch long, with yellowish black wings which are shorter than the abdomen. The tip of the abdomen projecting beyond the wings has a large T-shaped white spot. The female insect lays her eggs on the young pods in the field and the grubs eat their way into the seeds—usually only one to each seed. *Bruchus fabæ* is our most destructive weevil and is the species which infests cow-peas and table beans in store. This weevil is smaller than *Bruchus pisi* and is light yellow in color and quite hairy. This insect attacks the beans and cow-peas in the field in the same way as the pea weevil does. The pea weevil does not lay eggs upon the ripe or hard seeds, and there is only one generation of that weevil each year, but as soon as the bean weevil, *Bruchus fabæ*, has matured in stored beans or cow-peas it at once lays eggs on the hard seeds and these soon hatch into devouring grubs, which, after eating their fill, again produce the winged form to lay more eggs, and so on while the food supply lasts. A very few weevils in the stock of beans put into a bin in the fall may increase to millions by spring and ruin a thousand bushels of beans or cow-peas.

Remedies: The seeds of peas, beans and cow-peas, if the presence of weevils is suspected, should be plunged into water nearly scalding hot—140°F for five minutes before sowing. As soon as the seed is threshed out and before bagging for storage, it should be placed in a

tight bin, or hogshead, or piled in a conical heap on the floor of a tight room and subjected to the fumes of carbon bisulphide. Use about one pound of this substance for each ton of seed, and if done in a large room allow four ounces additional for each 25 or 30 cubic feet of unoccupied space. Carbon bisulphide is a clear, badly smelling liquid and is very explosive in presence of fire. To apply it, merely pour the requisite amount into an open dish and place this at the apex of the heap of seed, then spread a blanket or carpet over the whole so as to keep in the fumes. The liquid will quickly evaporate and penetrate the mass of seed, killing every insect. Allow it to stand covered for 24 to 48 hours, then uncover and expose freely to the air. The carbon bisulphide will soon disappear and leave no trace behind. It will not injure the seed for food or planting. Weevils or other insects in flour or meal may be destroyed in the same way. But in using this substance be particular to keep it away from the fire and from lights. Carbon bisulphide can be bought of most druggists at about 25 cents per pound.

The Clover-seed Midge, *Cecidomyia leguminicola*, is a pest very common in the clover growing districts of the Northern States, but as yet has not been reported among us. It will, however, certainly appear and increase as the area devoted to clover extends.

This insect is a two-winged fly, a sister species to the notorious Hessian fly, *Cecidomyia destructor*. In color it is bright red and not much larger than a grain of sand. The female lays her eggs in the young clover heads in early spring. These soon hatch into maggots, which feed upon the young ovules, causing them to wither and become worthless for seed. The maggot, when mature, drops to the ground and burrows beneath the surface or hides under trash piles, and there changes to the pupal and imago states. More eggs are then laid if clover can be found in bloom and a second or third brood produced. The last brood remains under ground or under piles of trash during the winter and comes forth to lay the eggs for the earliest spring brood.

Remedies: Where this insect occurs, the clover should be grazed until after the eggs for the first brood are laid and the winged insects have disappeared. These will be eaten with the clover, and if the first brood is thus exterminated there will be no second ones. But to succeed in this treatment, clover in corners and along fences must either be prevented from flowering until after the winged insect has disappeared, or cut and carried off and destroyed with the contained eggs and maggots. All the clover fields in any neighborhood must be thus treated, or the untreated ones will produce insects enough to infest the whole. Poisons are of no value in this case.

The Clover Root Borer, *Hylastes trifolii*, is a blackish brown, spotted beetle about one-tenth inch in length. The female in early spring lays her eggs in the crown of the plant and then dies. The eggs soon hatch into grubs which bore their way downwards into the roots, and usually remain within the root during the whole summer

and winter, transforming and emerging as winged beetles in the spring.

Remedies: Poisons will not do here, for though they might kill the insect while gnawing a hole for her eggs, they would also kill the clover plant itself, which is very sensitive. Moreover, it would be almost impossible to get the poison on the crown of the root. Where this pest is abundant clover fields should be plowed up and the herbage covered as deeply as possible and then rolled to bury the pest. Wheat or oats may then be sown upon the land. Gas lime spread fresh on the land at the rate of fifty to seventy-five bushels per acre will destroy all insects in the soil, but will at the same time kill all vegetation in the soil for six months or a year. If the lime is allowed to lie exposed to the air for a year it becomes harmless to growing plants without wholly losing its insecticidal properties.

The Clover Hay Worm, *Asopia costalis*, is a greenish-brown caterpillar, the larva of a pretty little moth about four-fifth inch across the expanded wings. The wings are purple with two yellow spots and a silky golden-colored fringe. The female lays her eggs only in stacked or mowed clover hay. In this dry clover the worms rapidly mature and destroy the value of the hay. They are always worst at the bottom of the stack or mow. There are two or three broods of worms each year.

Remedies: Thoroughly clean out the hay loft or bay of the barn before storing newly-cut clover hay. Burn the cleanings. Do not add fresh hay to an old stack or mow. If the hay is stacked outside, make the stack in a new spot each time and elevate it a foot or so from the ground to ensure circulation of air. Finally, if these worms, or any other noxious insects, are found depredating in the hay mow, fumigate with carbon bisulphide, as recommended for weevils.

The full notes taken during the growth of the Legumines heretofore described, will be found on the following pages. Should these pages be not received by parties interested, they can be procured upon application to
Dr. H. B. BATTLE, Director, Raleigh, N. C.

THE FORAGE PLANT GARDEN,

INCLUDING

FULL NOTES TAKEN DURING GROWTH.

By GERALD McCARTHY, Botanist, and F. E. EMERY, Agriculturist.

In the spring of 1891, in the month of March, a nearly square plat of low and rather moist, gravelly, red-clay land was laid off into 108 plats, each 4 x 17 feet with spaces of 1½ feet between. The land was thoroughly plowed and then worked with a disc harrow until in good condition for planting. It was then smoothed and raked by hand, and a complete ammoniated fertilizer was applied at the rate of about 800 pounds per acre. Other than this the plats received no fertilizer of any kind until spring of 1893, when all were heavily dressed with an acid phosphate. The seeds of all the species were sown broadcast and raked in by hand on April 7 and 9, 1891. In the notes which follow, the above series of plats will be referred to as the lowland garden.

On April 10, 11 and 13 another series of plats were sown on high red-clay land. This series of plats was undertaken in co-operation with the Botanical Division of the United States Department of Agriculture, and the work was under the sole charge of the Agriculturist of the station, who has furnished his notes for the present bulletin. The soil of the upland plats is a rather stiff red clay. It grew a crop of cotton in 1888, and in 1889 was used for a fertilizer experiment on cotton. In 1890 the land grew a crop of silage corn, and after the corn came off was sown with crimson clover which made a good stand, but showed strips where the fertilizer had been used or withheld in the cotton experiment of 1889. A moderately heavy dressing of stable manure was spread on those plats which produced little or no clover and the clover and manure plowed under in March. The land was then laid out, across the old fertilizer test-plats, into plats ninety feet long and four feet wide, with spaces of three feet between the plats. The seed was sown broadcast on the plats and raked in by hand. In the following notes this series of plats will be referred to as the upland garden.

Lucerne—*Medicago sativa.*

Description: A perennial, bushy, deep-rooting legumine. Pods twisted, flowers purple. Seeds resembling red clover. Hardy everywhere.

Lowland.—Sown April 7, 1891. Good stand by May 7. Grew finely and came into flower July 10, being about eighteen inches high. Flowers blue and purple. At this time the plat was found infested by dodder—*Cuscuta trifolii.* As an experiment the center of the plat, where the dodder was most abundant, was sprayed with the Bordeaux mixture (four pounds copper sulphate, four pounds lime to 22 gallons of water). The result was negative as to the dodder, but disastrous to the Lucerne, which withered and died to the ground and never afterwards reoccupied the ground wetted by the Bordeaux mixture, though still present and growing well along the edges of the plat where no liquid was applied. The dodder was removed by hand and burned.

Upland.—Plat sown April 13, 1891. Rather poor stand by May 11. Grew slowly and came into bloom July 20, being about one foot high. Was then cut and grew well, coming into bloom the second time August 31. Seed matured September 24. Left to fall on the ground. Plants stood the winter well and came into bloom May 20 and in seed May 30. Did not fill up the gaps between plants, and by September 7 was still very thin and in all respects inferior to its next neighbor, *Medicago media.*

Hybrid Medic—*Medicago media.*

Description: Resembles Lucerne, but plant does not grow so high. Flowers mostly yellow.

Lowland.—Supposed to be a hybrid between *M. sativa* and *M. falcata.* Plat sown April 7, 1891. Fair stand by May 1, but less vigorous than Lucerne plat. Grew fast and thickened so that by June 15 the plat showed more than twice as much foliage as Lucerne. June 23 coming into bloom and by July 10 was in full bloom. Holds its flowers longer than Lucerne and is less disposed to become woody. Plants about nineteen inches high. Flowers yellow and blue. Mowed in July to exterminate dodder. South half of plat sprayed with Bordeaux mixture, which seemed to have a much less disastrous effect than on Lucerne plat. Plants stood the unusually severe cold of the winter of 1892–'3 without damage. Growth well advanced by May 1, and stand excellent except where the Bordeaux mixture had been used. Here there was only a feeble growth.

Upland.—Plat sown April 11, 1891. Rather thin stand by May 13. Grew rather slowly and came into bloom July 20, being then from six to twelve inches high. Flowers blue and yellow. Seed ripe September 25. Seed left to fall on ground. Plants stood the winter excellently and by April 18 were in full bloom, a thick stand, but the stems very short. Luxuriant growth, decumbent on ground and spreading over the space between adjoining plats. Cut for seed latter part of June. Overripe and much of the seed shattered out and was lost. Did not spring again from stubble during the fall.

None-such or Hop-trefoil—*Medicago lupulina.*

Description: This annual legumine is well known and esteemed in the Mediterranean countries of Europe under the name of *Minette,* and in England as Hop-Trefoil. In America it is called None-such, and by some Black Medic.

Lowland.—Plat sown April 7, 1891. Fair stand by May 7. Grew slowly and by July 1 formed a very thick covering to ground. Stems creeping and about three inches high. Came into flower in late August. Flowers yellow. Pods black. Seed left to fall upon plat sprouted at once and remained green all winter. By April 15 in full bloom and very luxuriant. During summer the plat became infested by white and alsike clover from adjoining plats, and these, with crab grass, nearly smothered out the medic. In spring of 1893 the white clover had nearly undisputed possession of plat.

Upland.—Plat sown April 11, 1891. By May 11 a fair stand had started, growth was small and by August 31 began to blossom. After blooming old plants died out and new ones took their places until, by December 8, the plat was moderately well covered by small plants. In bloom April 15, a good stand of very short plants.

May 30 some seed was ripe and the plat was still covered with flowers. Cut for seed June 30. Much seed was shattered off and raked into the soil. By September 7 no new growth had started, but on April, 13, 1893, the plat was again covered with a dense growth of this clover.

SAINFOIN—*Onobrychis sativa.*

DESCRIPTION: A long-lived perennial legumine with pinnate leaflets. Flowers rose colored. Pods one-seeded. Seeds kidney-shaped. Roots long.

Lowland.—Plat sown April 7, 1891. Seed did not germinate.
Upland.—Plat sown April 13, 1891. Seed failed to grow.

SULLA—*Hedysarum coronarium.*

DESCRIPTION: A biennial legumine with pinnate leaves, scarlet flowers, jointed pods.

Lowland.—Plat sown April 7, 1891. By May 7 made a good stand and grew fairly through the summer. Did not bloom, and by September plat became very foul with crab grass. The plant had wholly disappeared by spring.
Upland.—Plat sown April 11. By May 11 a very thin stand, growth small and slow. Looked rather thrifty by July 25, but no flowers visible. By September 25 was nearly all dead. Plat was reseeded in spring of 1892, behaved much the same as in 1891, and was all dead by October 1.

SERADELLA—*Ornithopus sativus.*

DESCRIPTION: An annual, tall-growing pinnately leaved legumine, a native of Portugal, there much esteemed for sandy soils.

Lowland.—Plat sown April 7, 1891. By May 7 had made a very thin and poor stand. Grew slowly and thickened considerably till July 1. Plat being very foul was hand-weeded, which seemed to injure the seradella which soon died and was all gone by September 1. Plat was resown October 21, but seed failed to germinate.
Upland.—Not tried.

KIDNEY VETCH—*Anthyllis vulneraria.*

DESCRIPTION: A biennial or short-lived perennial which flowers the second year after sowing. Flowers yellow. Leaves the first year simple and strap-shape, after the first year pinnate, A native of Europe.

Lowland.—Plat planted April 7, 1891. By May 7 fair stand, but rather thin. Plants grew slowly, and being decumbent, with large leaves, nearly covered the ground by July 1. By August 15, plat had become foul with crab grass and infested with dodder. On half the plat the dodder was sprayed with simple solution of iron sulphate (one pound to five gallons of water). The dodder was in nowise hurt by the treatment but the plants suffered severely. The dodder was soon afterwards removed by hand with other weeds, but the kidney vetch never recovered, and soon died. All plants were gone by September 2.
Upland.—Plat sown April 11, 1891. By May 11 had made a rather thin stand, and much of the seed remained unsprouted. Grew slowly and remained small throughout the summer. Did not flower and was all dead by September 1.
Plat was resown March 7, 1892, at rate of forty-five pounds of seed per acre. Came up very thinly. Received an additional quantity of seed at rate of thirty pounds per acre June 30. Seed did not germinate, and plat was bare by September 1.

Japan Clover—*Lespedeza striata.*

Description: A low-growing annual legumine of the tick-seed tribe of plants. Flowers small, blue and purple. Leaves small, trifoliate. Native of Japan.

Lowland.—Plat sown April 7, 1891. By May 7 very poor stand, grew slowly until hot weather. Much improved by July 1, but never made a satisfactory stand before frost. Did not appear during the winter, and by May 1, 1892, plat was full of white clover which has held the land since, though never entirely supplanting the Lespedeza. The soil of this plat was rich and moist bottom land. On another plat less rich and moist than the above this plant gave much better results, and has to this day held the ground against all intruders except Bermuda grass, and against that is making a strong fight.

Upland.—Plat sown April 11, 1891. By May 11 no stand visible. By June 11, a few plants appeared and grew slowly and made a fair stand by October 1. Soon after disappeared. Plat resown March 7, using ten ounces seed (which was at rate of seventy-five pounds per acre). By April 21 plants were above ground, by June 30 a good stand but plants small. September 10 showed a thick and thrifty growth.

Hagy—*Lespedeza bicolor, var. intermedia.*

Description: A tall-growing perennial species of Lespedeza much used for meadows in Japan.

Lowland.—Plat sown April 7, 1891. By May 7 very poor stand. Plants grew spindling and weak and were soon smothered by crab grass and other weeds. In the fall a portion of the seed was soaked in water for twenty-four hours and then sown in shallow boxes in the Botanical Laboratory. Seeds germinated fairly, but plants were weak and grew slowly. Were transplanted from the boxes to small flower-pots and from these to the field plat in October, 1891. All were dead by spring.

Upland.—Not tried.

Soft Tick seed, or Beggar Weed.—*Desmodium molle.*

Description: A tall-growing semi-shrubby annual of the tick-seed tribe of plants. Flowers purple, leaves trifoliate.

Lowland.—Plat sown April 19, 1891. By May 19 made a very poor stand, but grew faster after weather became hot. By June 10 plants were twelve to eighteen inches high and resembled small bushes. By September 15 plants were two to four feet high, bushy and woody throughout. Flowers appeared September 15. Flowers blue and purple. The plants were killed by the first frost. The succeeding spring only a few plants came up from self-sown seed of the year before. These grew well and matured seed which was allowed to fall on the plat. In 1893 a good stand was in this way secured.

Upland.—Not tried.

Yellow Lupine.—*Lupinus luteus.*

Description: An annual, deep-rooting, very leafy, herbaceous legumine, growing about two feet high. Leaves simple. Flowers yellow.

Lowland.—Plat sown April 7, 1891. Grew well and by May 7 made a good stand. Came into flower June 20. Plants one foot high. Plat soon became foul and was weeded by hand, the lupines being mowed off. Plants did not recover or sprout from stubble, and by September 1 all were dead. Plat was resown October 20, but seed did not germinate.

Upland.—Not tried.

Spring Vetch.—*Vicia sativa.*

Description: Belongs to a well known species of annual legumines, of which there are two varieties—the spring and winter vetches. Stems lie on ground at base and then grow upright. Height about eighteen to twenty-four inches. Flowers purple.

Lowland.—Plat sown April 7, 1891. By May 7 a very good stand was obtained. Plants grew rapidly and came into bloom June 15. Dodder made its appearance early in June and the plat was mown on the 15th to get rid of it. Plants did not sprout again from stubble.

Upland.—Plat sown April 13, 1891. Oats were sown with it to hold the plants up. By May 13 a rather thin stand was obtained. By June 24 plants began to bloom, both vetch and oats were small. By July 20 the oat seeds were ripe, but the vetch died without producing seed.

Woolly Vetch.—*Vicia villosa.*

Description: An annual legumine indigenous to Germany. On good soil grows two and one-half to three feet, decumbent, lying on ground at base then growing upward. Leaflets oblong, ovate, covered with fine soft hairs or wool. Flowers dark purple.

Lowland.—Plat sown April 7. By May 7 a fair stand. Grew more slowly than *Vicia sativa.* In bloom by June 20 and plat infested by dodder. Full bloom July 1. Plants about eighteen inches high, decumbent. Foliage badly rusted. Plat mown July 11. Plants did not sprout again from stubble.

Upland.—Plat sown April 13, 1891. By May 13 a very thin stand was obtained. Plants grew slowly and lay prostrate on ground. Came into flower June 24. By July 25 ground was covered by the vines still in bloom. By September 25 seed was ripe, and plants soon after died.

Hairy Vetchling.—*Lathyrus hirsutus.*

Description: A twining, annual legumine, native of England. When supported, stems grow three to four feet high; when not supported, they lie on the ground. Leaflets narrow, lanceolate. Flowers purple.

Lowland.—Plat sown April 7, 1891. By May 7 a very poor stand was obtained. Plants grew very slowly, became rusted in July, and by October 1 were all dead without producing seed.

Upland.—Plat sown April 11, 1891. By May 11 only a few feeble plants alive. Grew very slowly, lying on the ground like a vine. Improved and grew better during the summer, and by September 1 had made a good stand, the vines had then covered the ground. Did little after September 1. The growth was low but dense and would have given good pasturage. It was grazed by stray animals during the Inter-State Exposition and they seemed to like it. April 18, 1892; plant has made a good growth which nearly covers the ground. Is now best of the legumines. By May 30 had made good growth and was ripening much seed. On June 30 was cut, but some seed was scattered on plat and raked in. On September 7 plat was marked "Failure," as there was then no visible growth. April 13, 1893, L. hirsutus was again in vigorous growth on its own plat, the adjoining paths and a part of the next plats adjoining plat.

Improved Flat Pea.—*Lathyrus sylvestris, Wagneri.*

Description: A perennial climbing legumine, native of Europe, where it grows in woods and is considered poisonous. Leaflets narrow, lanceolate, smooth. Flowers purple.

Lowland.—Plat sown April 11, 1891. By May 11 only a few feeble plants were visible. Plants grew very slowly and by July 1 had been smothered out by crab grass and weeds. Subsequently, seed was sown in a box indoors and plants transplanted to flower-pots and to the field in October. Plants were placed in the pear orchard, rich upland soil. They stood the winter without loss and grew very slowly during 1892. Growth at end of season did not exceed ten inches and lay flat on the ground. In spring of 1893 all plants were dug up and transplanted to a rich, loamy terrace where they grew very slowly during the season, being hand-weeded frequently. Plants have produced no flowers up to fall of 1893.

Upland.—Not tried.

False or Bastard Vetch.—*Phaca Bœtica.*

Description: An upright or bushy perennial legumine, native of Algeria and adjacent countries. Leaflets small and oval, covered with soft whitish wool. Flowers red.

Lowland.—Seed was sown April 1 in flower-pots and plants were transplanted to trial plat May 8. By June 8 plants were well established but did not stool and grew very slowly. When weather became hot plants rusted badly, and by September 15 were all dead without producing seed.

Upland.—Not tried.

Goober Pea.—*Voandzea subterranea.*

Description: Seed about size of a hazelnut and contained in a thick but soft rind. Plant of low growth, upright, reaching height of six to eight inches. Flower at base of stem small yellow. As soon as the flowers fall off, the young pod grows down into the ground and there matures after the manner of the pea-nut.

Lowland.—Plat sown May 20. Plants just visible June 8. Good thick stand. Plants grew slowly and by August 28 were six to eight inches high, with scant foliage. In flower. Young pods soon buried themselves in the ground. Pods dug October 14. Yield rather small, and not weighed.

Alsike Clover.—*Trifolium hybridum.*

Description: A perennial clover, supposed to be a hybrid between common red and white clover. Flowers pinkish or rose colored; on good soil grows about one foot high; seeds very small.

Lowland.—Plat sown April 7, 1891. By May 7 had made an excellent stand. Grew rapidly, but by June 20 plat was found badly infested with dodder. Was sprayed with simple solution of iron sulphate (one pound to five gallons of water). Plants badly scorched but dodder unhurt. Plat was then mowed and dodder destroyed, but the clover showed the evil effect of the iron sulphate during the whole season. By spring plat was much improved and plants began to bloom May 1. During the summer Bermuda grass appeared in the plat and gradually forced out the clover, but the clover spread to neighboring plats, where it grew vigorously.

Upland.—Plat sown April 13, 1891. By May 11 a very thin stand. Only a few plants on the plat; these came into bloom July 20. The seed produced was scattered on the ground. In spring of 1892 more seed was sown on plat at the rate of 15 pounds per acre. By May 30 the plat was well covered by vigorous stools of the clover. Seed ripe by June 30 and harvested. Sprouted again from stubble and gave thrifty plants by September.

GIANT WHITE CLOVER.—*Trifolium repens, var. latus.*

DESCRIPTION.—An improved Italian variety of the perennial, creeping, white-flowered clover so long and favorably known as a lawn and pasture plant. A native of Europe.

Lowland.—Plat sown April 7, 1891. By May 7 a good stand was obtained. Grew fast, and by June 1 was thick and fine, with much higher and broader leaves than common white clover. By June 15 plat showed presence of dodder and was sprayed with a solution of sulphite of lime, which scorched the foliage badly but did not kill any plants. No apparent effect upon the dodder, which was soon afterwards removed by hand. The clover flowered very sparingly and for some reason did not mature seed. Plants did not recover fully from the sulphite of lime before the advent of cold weather. Plants stood the winter well and started early the next spring. By March 1 was best of all the legumine plats. Grew well throughout the summer, attaining a height of six to eight inches, but bloomed very little and set no seed. During 1893 the plat behaved much as in the preceding year, but became considerably infested by Bermuda grass. The clover still, however, holds the ground well and it is spreading by runners into adjoining plats.

Upland.—Not tried.

COMMON WHITE CLOVER.—*Trifolium repens.*

DESCRIPTION: Creeping white, or Dutch clover. Strongly perennial.

Lowland.—Plat sown April 7, 1891. By May 7 had made a good stand. Grew well and came into flower July 1. During fall plat became overrun by crab grass and Bermuda grass. Remained green all winter and came into bloom by May 1. Second year behaved much as first year, keeping a thick stand and flowering freely during early summer and being overgrown by crab and Bermuda grasses during late summer. Has spread to neighboring plats.

Upland.—Not tried.

COMMON RED CLOVER.—*Trifolium pratense.*

DESCRIPTION: A biennial, tap-rooted legumine, with rose-colored flowers in close roundish heads. Leaves trifoliate, each leaflet having a V-shaped black blotch; stems smoothish and bushy. Pods one-seeded.

Lowland.—Plat sown April 7, 1891. By May 7 a good stand had been obtained. Grew finely and came into flower about June 1. Plat was found infested by dodder, and was sprayed June 15 with solution of sulphite of lime. Clover was slightly scorched by the liquid, and dodder not at all affected. Plat was then mown to extirpate the dodder. Sprouted quickly from stubble, but plat soon become infested by crab and Bermuda grasses, which completely hid the clover until cut down by frost. The clover began to grow again soon after January 1, 1892, and by May 1, made a heavy stand, and in bloom. The second year's growth was rather more vigorous than the first year's and there was no dodder, but the plat again in late summer showed more crab and Bermuda grasses than clover. Very little clover in the plat January 1, 1893. By May 1, plat showed a fair stand of white clover and later in the season the above mentioned grasses took possession.

Upland.—Plat sown April 13, 1891. By May 13 had made a very thin stand. Grew slowly and did not cover plat during the growing season. January 1, 1892, showed clover present in patches. March 7, 1892, four ounces additional seed sown on this plat. By April 15, only a poor stand was obtained. Thickened up somewhat during summer and furnished a crop of seed which was removed.

Mammoth Red Clover.—*Trifolium pratense perenne.*

Description: A short-lived perennial variety of the common species, with much longer, weaker and more hairy stems and long fibrous roots. Leaves not blotched.

Lowland.—Plat sown April 7, 1891. By May 7 a very fine and thick stand was obtained. Grew strongly and better than the common red clover plat all the season. Very little grass on this plat during the first summer. Soon after January 1, 1892, the clover renewed its growth and by March 1 was about eighteen inches high and very thick. Came into bloom May 15. Grew well during the summer, but towards fall became badly infested by crab and Bermuda grasses. In spring of 1893 plat was found occupied chiefly by white clover, with a few patches of mammoth red clover, which held their ground during the season but did not spread. Plat again became covered with crab and Bermuda grass during late summer.

Upland.—Not tried.

Medium or Zig-Zag Red Clover.—*Trifolium medium.*

Description: A short-lived perennial clover with zig-zag stems, leaflets without spots, and rose-colored flowers. Scarcely distinguishable from common red clover.

Lowland.—Plat sown April 7, 1891, By May 7 had made a good stand. Grew fairly well, and by June 15, became badly infested by dodder. Received same treatment as the ordinary red clover plat and with much the same result. Plat became grassy in late summer. By January 20, 1892, plat showed itself greatly inferior to the common red clover on adjoining plat, but during the summer seemed to hold the ground better against the encroachments of crab and Bermuda grasses. By spring of 1893 clover had wholly disappeared from plat.

Upland.—Plat sown April 13, 1891. By May 13 a very poor stand was secured. Only a few plants left by June 25. Grew slowly through the season and failed to cover the ground. March 7, 1892, four ounces more seed was sown on plat, but by April 15 only a scattering stand was obtained. Grew better later in the season, but never equalled the plat of common red clover.

Cow Pea.—*Dolichos catiang* × *sinensis.*

Description: A tender annual bean (not a pea), native of India, and largely grown for table use and as forage for cattle in all warm countries. The leaflets are large and thin, trifoliate. Flowers pale yellow or purple. There are many varieties in cultivation, chiefly distinguishable by the shape and color of the seed and vigor of growth. The following notes refer to one season's experiment only, though the plants have been grown on these plats two years. The notes for first season were in part lost.

UNKNOWN PEA.

Description: Seed slate-colored varying to whitish, angular with oblique ends. Stems extensively creeping, from four to ten feet long, the leaf-stalks attaining a height of eighteen to twenty inches on medium soil. A rampant grower with large glossy foliage, which resists rust better than any other variety.

Lowland Plat.—Plat sown May 20, 1893. By May 26 most of seed had sprouted and plants were visible. By June 3 a good stand was obtained, the plants being about three inches high. Grew rapidly, and by July 15 showed a heavy, thick mass of foliage fifteen to eighteen inches high. First flowers appeared August 25, and new flowers continued to expand until September 15. At this date the foliage was somewhat rusty, but less so than any other variety. On September 30 the first ripe pods were gathered. Vines showed an immense number of pods which, when ripe, were five to six inches long, and yellowish white in color, well filled with seeds. Pods usually twin. The larger part of the pods were ripe and gathered by October 15, but a good picking was secured October 24. The last ripe pods were gathered November 1, after two or three sharp frosts, the vines being then dead with a good number of immature pods still attached. Yield of seed two pounds six ounces per plat.

WHIPPOORWILL PEA.

DESCRIPTION: Seed brown speckled, rather large and flattish. Pods medium to short. Plant of medium growth, bushy, not creeping. Leaf stalks attain length of twelve to eighteen inches.

Lowland Plat.—Plat sown May 20. Plants visible by May 26. Excellent stand June 8. Grew rapidly and was in full flower July 15. Many pods ripe and gathered on July 28. Foliage very badly rusted, growth not luxuriant nor thick. At this date the 9-spotted lady bug was eating the flower-buds and did considerable damage. First picking of ripe pods September 2, last picking October 13. Most of the pods were picked by September 15. Yield of seed one pound eleven ounces per plat.

BLACK PEA.

DESCRIPTION: Seed glossy black, flattish. Pods long, scimeter shaped. Plant a vigorous grower, extensively creeping, three to five feet. Leaf stalks attain eighteen to twenty inches in height.

Plat sown May 20. By June 8 made a very good stand, with plants three to four inches high. Grew rapidly and by July 25 was eighteen to twenty inches high and in full bloom. Foliage badly rusted, and had nearly all dropped off by September 1. First ripe pods gathered September 2; last gathered September 15. Yield of seed one pound nine ounces per plat.

STEWART PEA.

DESCRIPTION: Seed blotched white and drab, small and angular. Pods medium length. Foliage medium to heavy. Flowers yellowish.

Lowland Plat.—Plat sown May 20. By June 8 a good stand. Grew rapidly and by July 15 was fifteen to eighteen inches high. First blooms July 25. First ripe pods gathered September 2; last picking September 30. Vines dead. Yield of seed one pound twelve ounces per plat.

LADY PEA.

DESCRIPTION: Seed small, whitish, with black eye. Pods short cylindrical. Plant medium to vigorous in growth, bushy, or somewhat creeping. Leaflets attain height of fifteen to eighteen inches. Flowers yellowish.

Lowland Plat.—Plat sown May 20. Plants visible May 26. Excellent stand by June 8. Grew well, and by July 25 was fifteen to eighteen inches high in full bloom. Foliage healthy. First ripe pods gathered September 2; second picking September 15, third and last picking September 30. All vines dead. Yield of seed one pound eight ounces per plat.

CONCH PEA.

DESCRIPTION: Seeds glossy white, round-oval. Pods unknown. Growth extensively creeping, twelve to fifteen feet. Leaf stalks attain height of eight to ten inches. Flowers unknown.

Lowland Plat.—Plat sown May 20. Plants visible May 26. By June 8 made a very good stand, plants two to three inches high. Vines elongated rapidly and foliage soon completely shaded the ground and smothered all weeds and wild grasses. Foliage remained healthy till cut down by frost. Stems attained length of eight to twelve feet. Did not flower. No seed.

"WONDERFUL" PEA.

DESCRIPTION: Seed, pod, foliage and general habit similar to the "Unknown" Pea.

Lowland Plat.—Plat sown May 20. Plants visible May 26. Very good stand by June 8. Plants three to four inches high. By July 1 plants were eight to ten inches high and foliage showed considerable rust, but seemed to improve later. Grew well and by August 25 was eighteen to twenty inches high and just coming into bloom. Foliage very thick and heavy, habit bushy but somewhat creeping, but in nowise different from the "Unknown" pea. First ripe pods gathered September 30. Second picking on October 7. Foliage badly rusted and falling, but vines loaded with pods. Next pickings were on October 13, 24, and November 1. Vines all dead, there having been several severe frosts. A large number of immature pods still attached to the vines. The seed of this variety was grown at the Station from seed procured the previous year from T. W. Wood & Sons of Richmond, Va. Yield of seed one pound fifteen ounces per plat.

RED RIPPER PEA.

DESCRIPTION: Seed dark red, large, round-oval. Pods medium long. Growth of plant vigorous, bushy, not creeping. Flowers purple.

Lowland Plat.—Plat sown May 20. Plants visible May 26. By June 8 made a very good stand. Grew rapidly and by July 15 was fifteen to eighteen inches high in full bloom. By August 28 three-fourths pods were ripe. Vines well loaded with pods. Foliage healthy and heavy. Dark green color. September 2 first picking of ripe pods. September 15 second picking. Leaves nearly all fallen off but fresh blooms still coming. Last picking October 7. Vines dead. The soil of this plat was unusually dry and poor, and on better soil a much larger yield might be expected. Yield of seed two pounds three ounces per plat.

CAPEHART'S RED PEA.

DESCRIPTION: Seed red and very similar to the Red Ripper, of which this seems to be a selected strain. Foliage, habit and flower similar to Red Ripper.

Lowland Plat.—Plat sown May 20. Plants just visible May 26. By June 8 made a rather poor stand. By July 15 was twelve inches high and creeping. August 15 in bloom. August 28 in fruit. Vines well loaded with pods. Foliage healthy, dark green and very heavy. September 2 first ripe pods gathered; September 15 second picking; October 7 last picking. Yield of seed one pound seven and a quarter ounces per plat.

SPECKLED PEA.

DESCRIPTION: Seed light grayish, speckled. Pods, flower and plant very similar to Whippoorwill.

Plat sown May 20. Plants visible by May 26. By June 8 had made a very good stand. Grew rapidly and promised to surpass the "Unknown" pea on a neighboring plat. July 15 plants eighteen to twenty inches high, bushy. August 15 in bloom. August 28 in flower. Foliage heavy and healthy. First ripe pods gathered September 2; second picking September 15; last picking October 7. Vines dead. Yield of seed one pound seven and a-half ounces per plat.

The Varieties of Cow-pea and their Comparative Merits.

The plant commonly known as the cow-pea in the Southern States is not a pea, but a bean, and would be more properly named the Indian or Hindoo bean. Our varieties seem to be a mixture of the two Indian species, *Dolichos catiang* or *ctang* and *D. sinensis.* The former at home has pale yellow flowers and the latter has purple flowers. Our varieties show both colors and mixtures of the two. Of the varieties tested on these plats, the yield of seed is pretty constant throughout, though in quantity of foliage and stem growth there was a very great difference. No attempt to compare the relative yield of forage or its palatability or nutritious properties was made this year, as it was desired to watch the plants during the entire period of growth from germ to seed. It was easily to be seen, however, that some of the varieties grew more than twice as much foliage and stems as others. The amount of seed produced was much the same with all varieties.

"*Unknown.*"—The "Unknown" pea is supposed to have originated in Georgia some twelve or fifteen years ago. It is there often called the "Innominate" and "No-name" pea. This for an all-around pea—for seed or forage or fertilizer—is the best of all the varieties of cow-pea. Its growth is remarkably vigorous, and when the soil is good and moist the growth of vine is enormous. Yet it does excellently well on dryer clayey land. It does not mature as early as other varieties, and therefore when grown for seed must be sown as early as possible and then, in this latitude, a good proportion of the unripe pods will be destroyed by fall frosts.

Whippoorwill.—This is a plant of medium growth of vine and matures its seeds very early. Planted May 20, many pods were ripe by July 28. In yield of seed it is as good as any, but its foliage is rather scant. This variety can be specially recommended for the mountain district and all sections north of parallel 38 North latitude. For central and eastern Carolina there are more vigorous growers.

Black.—The black cow-pea is the best known variety, and as an all-around pea is but little inferior to the "Unknown." It thrives in any soil not too dry and matures its seeds early enough to escape frost. In this test it had ripened most of its pods by August 28. It dropped its leaves soon after, and for forage must be cut before the pods are full grown. It does not become woody and gives a heavy yield of vine.

Stewart.—This pea seems to be a cross between the Lady-pea and the Clay-pea. It is of medium growth with healthy foliage and quite a prolific seeder. Seed matures early—the first pods on August 28 in this case. It should rank in value next to the Whippoorwill.

Clay.—This is a well known small, reddish pea, supposed to thrive better than any other variety on poor clay land. Our plat was upon fairly good moist land. The plant grew well and matured a good crop of seed, but it got mixed and could not be weighed. The samples of seed sent to the Station as "Clay" peas contained both light and dark colored seeds. The two kinds were separated by the Agriculturist and sown separately on adjoining plats. The dark seeds gave the more vigorous plants and outyielded the light colored seeds in both herbage and seed.

Lady.—This is a slender-growing variety bearing rather scant foliage. The seeds are cream colored and small and are well esteemed for table use. This variety is not recommended for forage.

Conch.—This is another variety from the Gulf States. It is the lowest growing and most extensively running of our varieties of *Dolichos.* With us it did not flower or seed, but was probably planted too close. The vines were ten to fourteen feet long and formed a tough matting nearly impenetrable. The foliage completely shaded the ground and kept the plat free from crab grass the whole season. On account of its low growth, the quantity of vines on the same space was, however, less than either the "Unknown" or Black pea. The vines formed a tough net-work that would have been very difficult to turn under. We are not favorably impressed with this pea.

"*Wonderful.*"—This supposed new variety originated in eastern Virginia two years ago. The grower got his seed from Georgia where it was called "Innominate" and "No-name." As already stated "Innominate" and "No-name" are in Georgia well known synonyms of the "Unknown." In our test, neither from the seed, flower, pod or habit of growth can these be distinguished. The one is not even a sub-variety of the other for, planted on the same date, both gave their first and last pickings on same date. The so-called "Wonderful" plat had a rather heavier growth of vine, but this was fully expected as the plat was on edge of a ditch and had looser and moister soil than the "Unknown" plat.

Red Ripper.—The Red Ripper or Long Red is one of the most esteemed varieties grown in Florida, where it is sometimes called Sand pea. It is a vigorous growing variety, ripening a good crop of seed about August 28. In the quantity of forage, it ranks next to the Black pea. The seeds are large and bright red in color. Edible qualities not tested. This pea can be highly recommended for the sandy lands of the eastern district.

Capehart's Red Pea.—This seems to be a select strain of the Red Ripper. Seeds larger than the above. Foliage much the same.

Speckled.—The seeds are about the size and shape of the Whippoorwill, but are of a light gray color. The plant is of robust growth quite bushy, the foliage is medium thick. Pods began to ripen August 28 and leaves rapidly fell off. This pea has some decided merits.

General Conclusion.—From two years observation of the differ-

ent varieties of cow-pea herein described, we draw the following conclusions:

1. The "Unknown" pea is by far the most vigorous grower, and on good average soil is the best pea to plant.
2. The new "Wonderful" pea is the old "Unknown" renamed.
3. The Black pea comes next to the Unknown in general usefulness.
4. For very sandy soil the Red Ripper promises more than any other.
5. The Whippoorwill is among the earliest to ripen its seeds, and where the growing season is short and a seed crop is desired, may be the best pea to use.
6. The Conch pea is an enormous runner and shades the ground very completely, but does not furnish as much herbage as any of the above varieties, and makes such a tangle of long tough stems that it is very difficult to turn under. It does not flower with us.
7. The other varieties possess no decided merit and may be discarded.

JAPAN OR MONGOLIAN PEA.—*Glycine hispida* AND RED BEAN, *Phaseolus radiatus.*

DESCRIPTION: The common Japan or "Soy" pea, more often, but wrongly called "Soja Bean," is a native of Japan and has been extensively grown in the South Atlantic States for the last ten years. It thrives upon the driest soil, and for poor dry uplands gives better results than the cow-pea. The plant, however, quickly becomes woody after blooming and is then rejected by stock. The peas have been broken, roasted and ground and in this condition make a decoction considered by many to be a fair substitute for coffee. This species is a tender, bushy, trifoliate annual. The *Phaseolus* species are true beans, not peas. They are all much smaller growers than the Soy peas, and have weak scanty foliage. As forage plants, they have little or no value. The edible quality of these beans is, however, unsurpassed by any except possibly the garden Lima bean. These red Japan beans are cooked in the same way as the common Navy bean. The pods burst as soon as ripe and unless gathered at once the beans will be lost.

JAPAN PEA No. 9.—*Glycine hispida*, variety.

DESCRIPTION: Seed dark green, spherical, large. Flowers purple or violet. Pods two inches, very hairy. Stems robust. Foliage rank, healthy.

Lowland Plat.—Plat sown May 20. Plants visible May 26. By June 8 plants five inches high. Grew strongly, and by July 15 plants were twelve to fifteen inches high. July 20 in bloom, flowers purple. Foliage very heavy and healthy. Plants woody at base. Pods all ripe and gathered at one picking October 13. Yield of seed one pound fourteen ounces per plat.

Japan Bean No. 5.—*Phaseolus radiatus.*

Description: Seed oblong, red. Flowers yellow. Pods one and a-half inches long. Growth bushy. Height eighteen to twenty inches. Foliage light green, healthy.

Lowland Plat.—Plat sown May 20. By June 8 a good stand with plants three inches high. Grew rather slowly and plat became very weedy. By July 15 plants twelve to fifteen inches high. July 25 plants in bloom, flowers white. August 28 foliage rather badly rusted. September 15 all pods ripe and gathered at one picking. The pods burst spontaneously when ripe and on this account there is a heavy loss of seed unless gathered at intervals as the pods ripen. Yield of seed ten ounces per plat.

Japan Pea No. 7.—*Glycine hispida*, variety.

Description: Seed small, spherical, cream color. Flowers white. Pods one and a-half inches long, very hairy. Stems sixteen inches high but slender and weak. Foliage medium, healthy.

Lowland Plat.—Plat sown May 20. Plants visible May 26. By June 8 a very poor stand, plants two to three inches. Grew slowly, flowering July 10. Flowers white. Plants twelve to fifteen inches high. Foliage thin but healthy. Pods nearly all ripe August 30. All gathered at one picking September 15. Yield of seed eleven ounces per plat.

Japan Bean No. 6.—*Phaseolus radiatus*, variety.

Description: Seed small, oblong, red. Flowers yellow. Pods small and hairy. Stems low and weak. Foliage scant.

Lowland Plat.—Plat sown May 20. Plants visible June 1. Fair stand by June 8. Plants one to two inches high. Grew fairly well and by July 15 were eight to ten inches high. July 28 in bloom, flowers yellow. Foliage scant but healthy. Pods ripe and all gathered at one picking September 15. Yield of seed twelve ounces per plat.

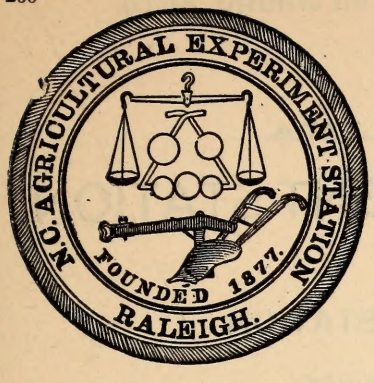
Japan Pea.—*Glycine hispida*, common Soy Pea or "Soja Bean."

Description: Seed spherical, glossy light yellow, very hard. Pods small, very hairy. Plant bushy, vigorous growth. Foliage light green. Flowers white. Stems become woody soon after flowering.

Lowland Plat.—Plat sown May 20. Plants visible May 26. Good stand by June 8, plants three to four inches high. Grew vigorously, and by July 15 plants were twelve to fifteen inches high. By August 25 in bloom. Flowers white, small and very abundant. Stems twenty to twenty-five inches high. Foliage healthy, light green, very luxuriant. Pods ripened slowly, being still green October 13. All gathered at one picking October 24. Yield of seed unrecorded.

The Japanese Peas and Beans.

As forage plants the common so-called Soja Bean, more properly named Soy Pea, is by far the best of all these plants. It is later than Nos. 7, 8 and 9, but grows much more luxuriant and will give from 50 to 100 per cent. more forage per acre. Further north, and in the mountain district, where the season is shorter, the more rapidly maturing varieties may have some value as forage plants. But for forage this plant should be cut before it becomes woody, and that is as soon as the flowers begin to appear. For this purpose three months growth is nearly or quite sufficient.



April 15, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 99.

THREAD-WORM OF PORK (TRICHINA SPIRALIS.)

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

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RALEIGH, N. C.

THREAD-WORM OF PORK (TRICHINA SPIRALIS.)

There is so much danger to human life from eating pork infected with thread-worms (*Trichina spiralis*) that the public generally should be warned of the fact and become more familiar with the life-history of the worm, and wherein lies the source of danger. This knowledge would enable them to adopt measures not only for preventing its entrance into the human system, but also to prevent its spread in other animals, and so decrease the liability of contagion. To give this information in a condensed form is the object of the present bulletin, written by Dr. F. P. Williamson, Consulting Veterinarian to the Experiment Station. The Station is much indebted to the Bausch & Lamb Optical Co., of Rochester, New York, for the loan of the electrotypes used, which are from an interesting pamphlet, entitled "Trichinæ," by John Phin.

The disease produced by the pork or thread-worm must not be confounded with that produced by the tape-worm (*Tænia solium*), though the manner in which it reaches the human system is almost identical, namely, by eating imperfectly cooked meat infected with the immature forms, or by eating green vegetables which may be affected in the same way. A discussion of the tape-worms, *Tænia solium* and the *Tænia echinococcus*, will be reserved for a future bulletin.

H. B. Battle, *Director.*

TRICHINA SPIRALIS, OR THREAD-WORM.

By F. P. WILLIAMSON, Consulting Veterinarian.

The most common way in which human beings become infested with trichina is, undoubtedly, from eating trichinous pork. John Phin gives three other ways in which animals may become affected, *i. e.*, eating excrementitious matter of animals themselves affected, by drinking water in which the flesh of animals affected has decomposed, by eating vegetables (cabbage, lettuce, celery) manured with excrement or offal of animals affected.

Trichina spiralis (coiled hair), or thread-worm, derives its name from the appearance presented in their encysted form. It is as interesting as any of the animal parasites that inhabit carnivora.

The position they occupy in the classification of worms can be seen from the accompanying diagram (after Minot).

Branch.	*Class.*	*Genera.*
Vermes. (Worms).	I. Plathelminthia.	
	II. Rotifera.	
	III. Gastrotricha.	
	IV. Nematoda	Leptodera (Vinegar Eel.)
		Rhobditis (Lung Worm of Frog.)
		Anguillula (Root Worm.)
		Enoplus (Aquatic Worm.)
		Filaria (Guinea Worm.)
		Trichina (Muscle Worm.)
		Trichocephalus (Bowel Worm.)
		Eustrongylus (Trachea Worm.)
		Syngamus (Gape Worm.)
		Oxyuris (Pin Worm.)
		Ascaris (Bowel Worm.)
		Gordius (Hair Worms.)
	V. Acanthocephali.	
	VI. Chætognathi.	
	VII. Nemertea.	
	VIII. Gephyrea.	
	IX. Annelida.	

Others of this group are not so important as trichina spiralis, but are more often found; some of these are trichocephalus dispar (whip-worm), which is found at times in both large and small intestines; oxyuris vermicularis (sharp-tailed worm), which lives in the intestines; eustrongylus gigas (round worm), which is found in the kidneys, rarely elsewhere; dochmius duodenale, which inhabits the small intestines, causing at times violent diarrhœas.

Thread-worms can best be seen in their encysted form, where they lie coiled up in a calcareous mass of their own deposit (see Figures 2 and 3) in the muscles of carnivorous animals. To the naked eye the cysts appear as grains of sand (Figure 1). So long as they remain in this shell they are harmless. But when some other animal eats the flesh of the one in whose muscles the trichinæ are encysted, they are set at liberty in the alimentary canal of the new host, there to produce young and die. The young then burrow through the intes-

tinal walls to become encysted and embedded in muscular tissue as before.

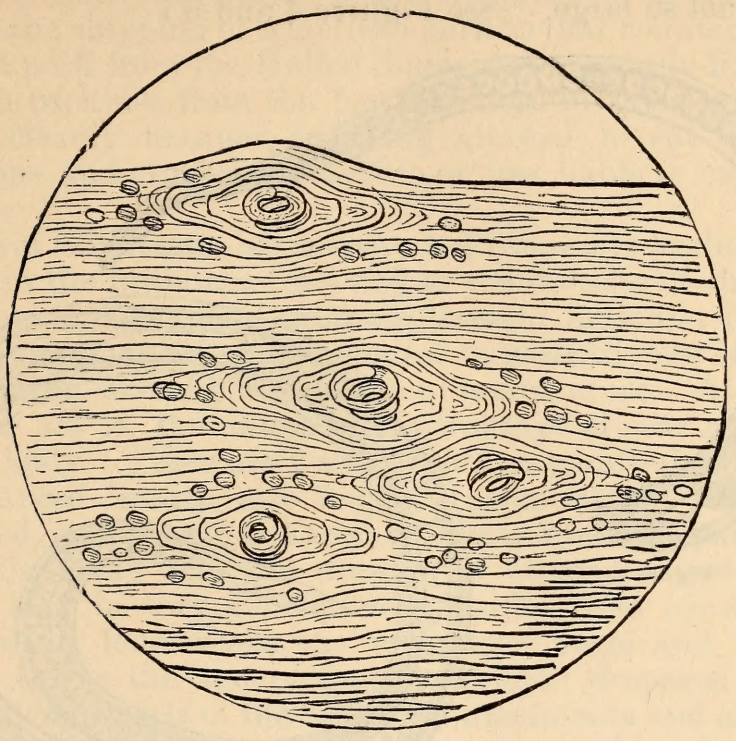


Figure 2.

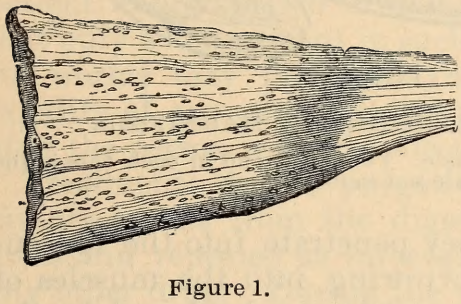


Figure 1.

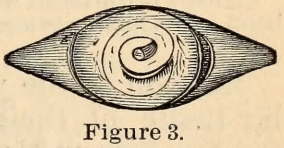


Figure 3.

TRICHINA SPIRALIS IN FLESH IN THE ENCYSTED FORM.

Figure 1 shows the appearance of these parasites in meat examined with the naked eye. Figure 2 shows a microscopic section, magnified 25 diameters. Figure 3 shows a section of a cyst still more highly magnified.

These are encysted forms in which it is possible to exist 10 or 20 years without damage and without losing power. After the flesh is eaten, the cyst is dissolved and the worm is set free to bore its way through the flesh, multiply and produce the disease known as trichinosis.

Let us follow the course of these micro-organisms more in detail through their life-history.

Take pork in which are some encysted trichinæ. They are then in the larval form about $\frac{1}{28}$ of an inch in length. Twisted up on themselves like a spring in their egg-shaped cyst of lime, they lie dormant, yet ever ready, when set free, to cause as much suffering as any of the parasites that infest the human body. When infested flesh is eaten, the encysted trichinæ set free can be found in the small intestines. According to Gottheil they develop in one and a half days. They are now sexually mature, losing their spiral form and

reproduce in seven days. They increase very rapidly, each female bearing about 1,000 living young. The female is $\frac{1}{8}$ inch in length, the male not so large, (See Figures 4 and 5.)



Figure 4.

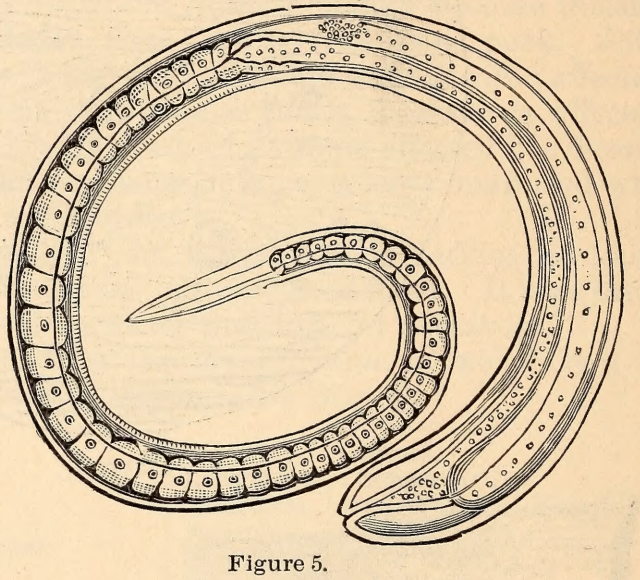


Figure 5.

MATURE FORMS OF TRICHINA SPIRALIS, HIGHLY MAGNIFIED.

Figure 4 is the adult male. Figure 5 the adult female. The small end in each case is the head. The female is about $\frac{1}{8}$ inch in length, the male not quite so large.

As soon as the young are set free they penetrate into the muscular tissue of their host, sometimes burrowing into the muscles of the far extremities, but the greatest number can be found in the abdominal and thoracic muscles. After a time these small trichinæ become encysted. It is possible for adult trichina to be found in the alimentary tract of all animals in whose muscles they have been found encysted.

Trichiniasis, trichinosis, trichinitis, trichina, or trichinous disease is the name given to the disease caused by Trichina spiralis.

The encysted trichinæ were found in the dissecting room thirty years before the disease was diagnosed. Zenker was the first to discover the clinical nature of the disease, in 1860. He records the death of a patient who died of trichiniasis, whose case in life, from its symptoms, was said to be typhoid fever. The post-mortem examination showed larval trichinæ encysted in the patient's muscles, also mature trichinæ in the intestinal canal.

Epidemics have occurred in North Germany at different times from eating uncooked pork, and also in England, in New York State,

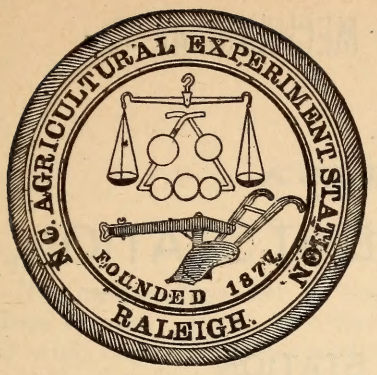
and elsewhere. They were so disastrous in Germany at one time that the government appointed a commissioner to examine pork, and forbade the shipping of American pork to that country. It was claimed that pork from the United States was especially liable to be infested with trichinæ, from the fact that hogs in this country were not fed in cleanly manner, in being allowed to eat offal from slaughter pens and other matter more or less liable to contain the worms.

The cause of this disease has already been shown to be the presence of trichinæ in the intestinal tract and in the muscles of the patient. The effects upon the system resemble those of muscular inflammation. The symptoms are at first similar to gastritis, loss of appetite, nausea, vomiting, and slight elevation of temperature. At this time the trichinæ are in the intestines. Swellings appear at different parts of the body. These are very painful on manipulation. Thirst is now a marked feature, also frequent perspirations, temperature more elevated, and pulse quickened. This is when the parasites are burrowing their way into the muscles to become encysted there. The patient may be very constipated or suffer from constant diarrhœa. In about four weeks the symptoms abate and the fever diminishes; this is the time of great weakness; dropsical effusions appear at different parts of the body, and pneumonia and other complications are liable to occur. Death may end the misery of the patient at any period of the disease. It must be stated, however, that only when present in such large numbers as many millions that the worms may produce dangerous results. But from the great rapidity of reproduction it is not very difficult to reach this number after the person is much infected.

Treatment: Active purgatives should be given to remove the mature worms from the digestive tract. Calomel given in large doses and repeated at intervals has been found to act better than any other drug. During the weak state the strength of the patient should be looked after, and some of the numerous beef-tea extracts would be serviceable.

But the greatest of all remedies is preventive treatment. Always cook meat thoroughly before eating. A temperature of 175°F. (and this temperature should be reached at the centre of the piece of meat cooked as well as the surface) destroys these parasites. Be careful not to let hogs have access to offal or to excrement of any kind, and above all, allow no dead rats to be thrown in the pig pen, for rats are great spreaders of diseases of this nature. The practice of feeding pigs on slaughter-house offal should be absolutely condemned.

Why is it not as wise to enforce strict sanitary regulations in regard to health of animals whose flesh is to be eaten, as to our own personal health?



March 26, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 100.

OUR COMMON INSECTS.

Publications will be sent to any address in North Carolina upon application.

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RALEIGH, N. C.

OUR COMMON INSECTS.

The causes that led to the publication of a bulletin upon the above subject were several: *First*, in order that the people of the State should have the means of studying and understanding the numerous insects, both foes and friends, constantly noted on every side. It is evident that this can be done to better advantage if the structure, classification, and life-history are known in connection with a knowledge of a particular specimen when it is being studied. *Second*, to extend a spirit of investigation and study among the children of the State, both at their schools and at home. It is expected that this will be accomplished by creating an interest in the collection of insects, and their preservation for permanent interest and value. In this way, if the activity of the children is aroused it will undoubtedly extend to the parents, and to both will result a better knowledge of insects and methods designed to destroy them. Many simple remedies can be applied that would save many crops to their owners if only these remedies were known. To aid in the creation of interest in the study of insects, the preservation of beneficial species, and the destruction of noxious ones, it is probable that the Experiment Station will offer cash prizes for the most meritorious collections of insects collected and named according to the classification of the present bulletin. The offer will doubtless be made only to the public schools of the State and their pupils. *Third*, to increase our own knowledge of the insect fauna living in the borders of the State, and in this study, collections carefully made as above described and sent in from all parts of the State, will be invaluable. The flora of North Carolina has been studied widely and is among the richest and best known in the world. In fact, the name *Caroliniana* appears as a part of the specific name of plants more frequently than that of any other State. This is doubtless due to the researches of two of her citizens of world-wide reputation, Dr. L. D. von Schweinitz of Salem, and Dr. M. A. Curtis of Wilmington, and of Michaux, the elder and younger, and other European botanists, who did most of their collecting in North Carolina. The flora of the State embraces some 6,000 distinct species, due to the varied elevations within her borders, and the consequent diversification of climate. As there is such close connection and mutual dependence between plants and insects, it is doubtless the fact that there is relatively as large insect fauna within the State and as interesting as the flora. No such attempt has ever been made to systematically study our insect life. It is desirable that a beginning should be made, and collections from different portions of the State carefully made by the various schools would be of great assistance in the work. At the same time, collections made in this way would tend to increase the interest of school pupils in natural sciences, would teach them the value of observation of the life and events around them, and which, in addition, would be of marked value to them in after life as agriculturists. This interest would doubtless extend to their parents, who would in turn derive benefit from their labors.

With these three purposes and results in view, the present bulletin was written by the Entomologist of the Station, Mr. Gerald McCarthy. Its scope can be seen from the table of contents on the following page. Of the sixty-five cuts used to illustrate the text, the following very instructive ones were very kindly loaned by Dr. Otto Lugger, Entomologist of the Minnesota Experiment Station, and to whose courtesy we are greatly indebted: Nos. 1, 2, 9, 11, 23, 35, 36, 37, 38, 41, 41a, 51, 53, 54, 57, 58, 59, 60, 61, 62.

H. B. BATTLE, DIRECTOR.

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[The above Table of Contents presents a condensed Summary of the several subjects treated in this Bulletin. The detailed matter will be found in the following pages (185 to 216). Persons who do not receive these latter pages can be supplied by making application for the complete Bulletin to Dr. H. B. BATTLE, Director, Raleigh, N. C.]

OUR COMMON INSECTS.

By GERALD McCARTHY, Entomologist.

During the warmer months of the year, insects, including flies, beetles, bugs, butterflies, moths, etc., are everywhere among the most abundant of living creatures. Insects are always interesting on account of their colors, form and sounds, and frequently annoying by their attacks upon ourselves, our animals, and our crops. To farmers, gardeners and fruit-growers, the life-histories of many insects is a matter of no small interest. Many species of noxious insects are so common and destructive to crops as to inflict each season very serious damage; at times they may invade whole counties in such swarms as to sweep away in a few days every green plant, and threaten famine to the people of the invaded district. Not every species of insects is noxious. The useful honey-bee and silkworm moth have been domesticated for ages. Many other species are useful by carrying the pollen of one flower to the pistil of another flower, thus causing cross-fertilization and better crops. Still another class of insects benefit mankind indirectly by preying upon noxious species. It is desirable, then, that farmers and gardeners should learn to discriminate useful from noxious insects. During the last 25 years, the number of noxious species of insects has increased with the most alarming rapidity.

It is necessary now that everyone who cultivates or has charge of a farm, garden or fruit yard should be sufficiently acquainted with the life-histories of noxious species to be able to combat them intelligently, and at the period when they are most exposed to attacks. Owing to the great difference in the appearance and habits of insects at different stages of growth, different methods must be employed against the same species at different times.

The present bulletin is an attempt to bring together in a short space and a popular form the principal facts of classification and history of the orders and genera of insects most common with us, in the hope that it may lead our farmers, their sons and daughters, to pursue this study further with the aid of special text-books, some of which will be named at the end of this bulletin. Another object is to induce young people to make a collection of the insect fauna of the State, and thus increase their knowledge of the subject and arouse additional interest in its study. All insects collected and forwarded to this Station according to the instructions given in this bulletin

will be identified and named free of charge, and all possible aid will be given to those who desire to engage in the work.

The particular science which treats of insects is called Entomology. The word is of Greek derivation and means a discourse about insects. "Insect" is from two Latin words which mean something cut into parts or rings such as make up the bodies of insects. For convenience in study, men of science have arranged all natural objects under three principal and many subordinate divisions. The principal divisions are the mineral, vegetable, and animal kingdoms. It is easy to tell at a glance to which of these kingdoms any ordinary object belongs. Insects obviously belong to the animal kingdom. The annexed diagram shows their relationship to other animals, and to nature at large.

The classification of insects is not yet permanently fixed. Some authors arrange the whole subclass of insects under seven orders; others make as many as 16 or 20 orders. The seven-order arrangement is the oldest, is very simple and, for practical purposes, is as good as any. We shall adopt this classification in the following pages:

CLASSIFICATION OF INSECTS.

Kingdoms. — *Series.* — *Branches.*

- Nature
  - Minerals.
  - Plants.
  - Animals.
    - Vertebrates (with backbones).
    - Invertebrates (without backbones).
      1. Protozoa (uni cellular animals).
      2. Porifera (sponges).
      3. Cœlenterata (corals, jelly fishes).
      4. Echinodermata (star fishes).
      5. Vermes (worms).
      6. Molluscoideæ (sea polyps, etc.).
      7. Mollusca (oysters, clams, etc.).
      8. Arthropoda.

Branch 8. Arthropoda. — *Classes.* — *Subclasses.* — *Orders.*

- Crustaceans (crabs, lobsters, etc.).
- Insects.
  - Malacopoda (peripatus).
  - Myriapoda (centipedes, etc.).
    - I. Chilopoda (centipedes).
    - II. Pauropida.
    - III. Diplopoda (millipedes).
  - Arachnida (spiders and mites).
    - I. Arthrogastra (scorpions).
    - II. Araneina (spiders).
    - III. Acarina (mites).
  - Hexapoda. — *Orders.*
    - I. Hymenoptera (bees, wasps, etc.).
    - II. Coleoptera (beetles).
    - III. Lepidoptera (butterflies, etc.).
    - IV. Diptera (flies).
    - V. Hemiptera (bugs).
    - VI. Arthroptera (grasshoppers, etc.).
    - VII. Neuroptera (dragon flies, etc.).

The term "insect" is used in a somewhat different sense by different scientists. Some include under this name spiders, mites and centipedes—insected animals which have eight or more feet. Others restrict the name to six-footed insected animals. The best authorities, however, as well as nearly every intelligent non-scientific per-

son, consider mites, centipedes, spiders, etc., true insects. A special subclass *Hexapoda* (six-footed) is given for the six-footed insects, which, in addition to having just that number of legs, differ from spiders, mites and centipedes by the series of changes, or *metamorphosis*, through which they pass from the egg to the adult animal. Let us take the very common "cotton caterpillar" as an illustration of the changes through which most species of insects pass. First, there is the egg which the parent moth lays on the cotton plant. From this at the natural temperature of the air there hatches in two or three days a tiny caterpillar which looks more like an ordinary earth-worm than the winged parent moth. This caterpillar grows quite rapidly, casting off its skin like an old coat every four or five days. During this period it is, as farmers well know, a most voracious feeder, eating more than its own weight every 24 hours. At the end of about 20 days the caterpillar is full grown, stops feeding, and rolls itself up in a leaf of the cotton plant which it fastens together securely with silk threads. In this retreat it casts its skin for the last time and appears as a "chrysalis," which is a dark-brown, legless and seemingly lifeless object very different from the caterpillar. In the chrysalis state it remains dormant for about a week or ten days, and then bursts forth as a winged moth precisely like the parent moth. The sexes pair after a few hours and the female moth begins to deposit eggs, which pass through the same series of transformations. All our six-footed insects do not pass through the whole series of changes described above, there being various degrees of incomplete metamorphosis. The female of most species of insects lays from 50 to 3,000 or more eggs. The usual duration of the life of a winged insect is, in summer time, only a few days or weeks, though in cold weather a winged insect may live in a dormant or cold-benumbed condition through the winter, and wake up to lay eggs in the following spring. In the second or *worm-like* state, the "larva," the insect commonly lives for from a month to a year. A few species live two or three years, and the 17-year cicada lives in this form in the ground for from 13 to 17 years. It must always be borne in mind that though we shall frequently call insect larva "worms," we do so only out of deference to common usage. They are not true worms. Worms belong to the fifth branch of the invertebrate series. [See diagram, page 186]. The "pupa" state, in which the insect changes from a worm-like animal to a winged one, lasts, as a rule, but a few weeks, usually less. Before passing into the pupa state many insects construct protection cases. The pupa case is usually called the cocoon. In many species the cocoon is a very elaborate affair, as, for example, that of the silkworm, from which the raw silk of commerce is obtained. In other species the cocoon is quite rude, or wholly lacking. Although many species pass the pupal stage above ground, the majority burrow into the ground for this purpose. There they make a kind of cell and cement or line the sides with mucus or silk.

Insect Names and Organs.

The scientific name of insects always consists of two or three words—which are Latin or Greek. The first word is the generic name, which corresponds to the family name of humans; the second word is the specific name, similar to the given name of humans; a third word is sometimes used to express a varietal distinction—the generic name of insects differing from human names in that it always precedes the specific name. The names used in science are often difficult to pronounce and to remember and are to most people meaningless. Yet the use of common or vernacular names cannot be accepted in science, because one species often has several names in the same neighborhood, and in foreign countries each language has different common names for the same species. The Latin and Greek names are the same in all countries, and thus confusion is prevented by using them.

All six-footed insects breathe through tubes called *trachea*, which open along the sides of the worm-like" larva," and under the wings of the adult or "imago."

The bodies of all Hexapodous insects are divided into three well distinguished parts, and each separate limb and portion of a limb has a special name. Figure 1 shows a grasshopper dissected into distinct parts, to each of which its proper name is given. (See Fig. 1.)

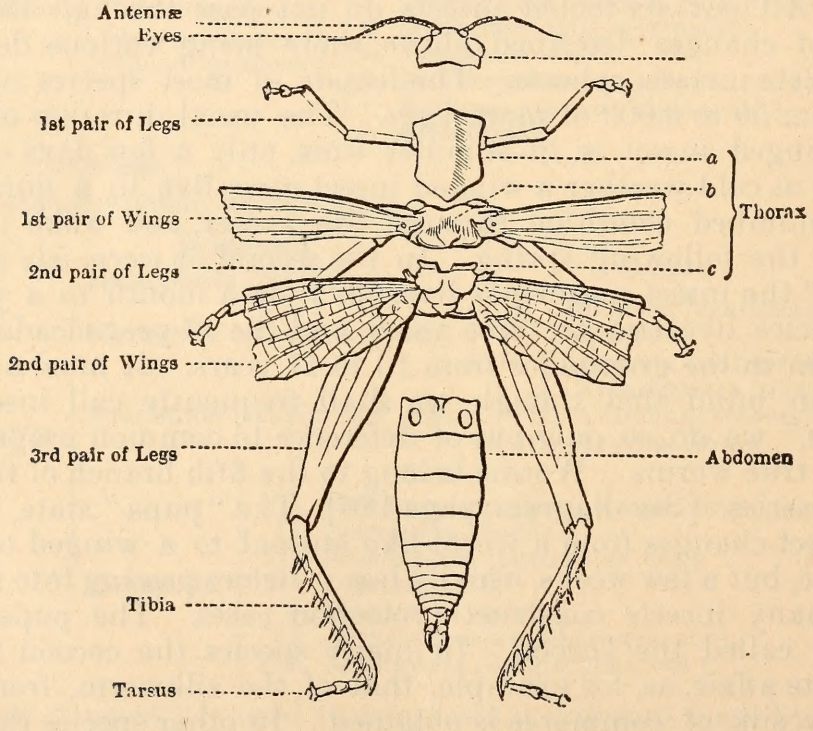


Fig. 1. A dissected insect.

The first joint or segment is the head. To this are attached the *antennæ*, or feelers, and eyes. The second joint has attached the first pair of legs; the third joint has attached the first pair of wings and

second pair of legs; the fourth joint has attached the second pair of wings and third pair of legs. The second, third and fourth joints are collectively called the chest or *thorax*. Although shown as separate parts in the figure, in case of most insects these three portions are so closely joined that it is difficult to distinguish the separate joints. The remaining joints form the *abdomen* of the insect. To this division are attached the sexual organs, but these are not shown in the figure. The leg of a Hexapodous insect is divided into five distinct parts, to each of which a separate name is given. The joint next to the body is called the *coxa*. The second joint of the leg is called the *trochanter*. In the figure the *coxa* and *trochanter* are hidden by the wings. The third joint is the *femur*, the thickest portion of leg; the fourth joint is the *tibia*, the fifth joint is the *tarsus*.

SUBCLASS—HEXAPODA OR HEXAPODS (SIX-FOOTED INSECTS).

Order I.—Hymenoptera, or Membrane Winged Insects.

This order includes the honey and bumble bees, wasps, hornets, red and black ants, ichneumon flies, saw flies, horn tails, and a few other genera. The Hymenoptera have mouth parts fitted both for sucking and biting. They have four membrane-like wings, and the metamorphosis is complete. The tip of the abdomen in the female ends in a sting or lancet, which is also an egg tube or ovipositor. This is one of the smallest of the natural orders, and for intelligence and value to humanity stands at the head of the entire class of insects.

As is well known, bees and ants live in well organized communities with division of labor. The most useful and best known of insects is the honey-bee, *Apis mellifica*. The honey-bee is not only useful for its honey, but also because it helps to cross-fertilize the flowers of plants. This insect often pierces or tears the rind of fruits and then sucks their juices, and when nectar-giving flowers are scarce it undoubtedly often does considerable damage in this way; but its principal food is the nectar of flowers, and its benefits far outweigh its occasional depredations. In searching for nectar it carries the pollen of one flower to the pistil of another, thus causing cross-fertilization, without which our crops would soon deteriorate. Each hive contains one queen or mother-bee, and during the swarming period some one hundred or more male or drone bees. The rest of the bees, amounting to some thousands, are all neuters, or working bees. The queen, or, more properly, mother-bee, lays something like a million eggs during her life, which may last for three to five years. The drones are ruthlessly stung to death by the workers as soon as the last queen has emerged from the cells and left the hive. The drones usually live but a few weeks. The worker bees in summer time die a natural death at six or eight weeks of age—their places

being continually filled by those newly hatched. The queen or mother-bee lays her eggs in certain cells in the comb. The eggs hatch in a few days into small, footless, and very helpless grubs, which are tenderly cared for and fed by the workers until they have passed through the whole cycle of changes and become winged, when they take their places as workers. Queens are produced from eggs laid in extra large cells, in which the grub is fed with a special kind of food called "royal jelly." Male or drone bees are said to be produced from unfertilized eggs, but this is rather doubtful and contrary to general experience.

The bumble bee is far less intelligent than the honey-bee. It lives in small colonies in holes in the ground. There are also several species of bumble bees which live solitary lives.

Of wasps (genus *Polistes*) and hornets (genus *Vespa*) we have several genera which are social and live in small communities. There are also solitary genera. Wasps do not secrete wax like bees. They make nests or cells of a substance resembling paper, made by chewing bits of wood. Some make nests of mud, plastered against walls of buildings. Solitary wasps usually burrow in the ground. The winged insect feeds upon pollen and the nectar of flowers, but the larva or grub feeds upon other insects, which are provided by the mother. Wasps and hornets, in spite of their pugnacity, are very useful insects, as they destroy vast numbers of noxious insects in providing feed for their young. They never attack men or animals except in self-defence.

Ants (genus *Formica*) are among the most interesting and intelligent Hymenoptera. Most ants, as we see them, are wingless; but at certain periods the female and male ants possess wings, which they subsequently drop as useless. Ant-hills like bee-hives contain three forms of insects—males or drones, females or queens, and neuters or workers. Some of the neuters are of extra large size and seem to be the soldiers or police of the colony. A single ant-hill or burrow may contain over a million insects. Ants are very intelligent, and not only provision their nests for time of scarcity, but also domesticate other insects, such as aphides, which they care for much as men do for domestic animals. Some kinds of ants even enslave other species and compel these to do the work of the colony. Ants are chiefly vegetable eaters, but they eat flesh when they can get it, and in the cotton fields of the South they do good service by killing and devouring cotton and boll-worms. The common yellow ant, which lives in cracks of floors and closets in houses, is *Myrmica molesta*, and though often a great nuisance it does useful work as a scavenger.

The Ichneumon and Chalcid Flies (see Fig. 2), of which there are a great many genera and species, are probably the most useful of all predacious insects in repressing the undue expansion of noxious species. The female fly lays her eggs upon the bodies of caterpillars and grubs, and with certain species upon the eggs of other insects. When the parasitic eggs hatch, the young grubs eat their way into the body of their host, and feed upon it, eventually killing it. The

horn-tails are wood-boring larvæ and do a vast deal of damage to elms, maples and other shade trees. Our most destructive horn-tail is *Tremex columba;* its most potent enemy is the Ichneumon fly, *Thalessa lunator*, which has an ovipositor several inches long, by means of which it can reach the borer at the bottom of its burrow.

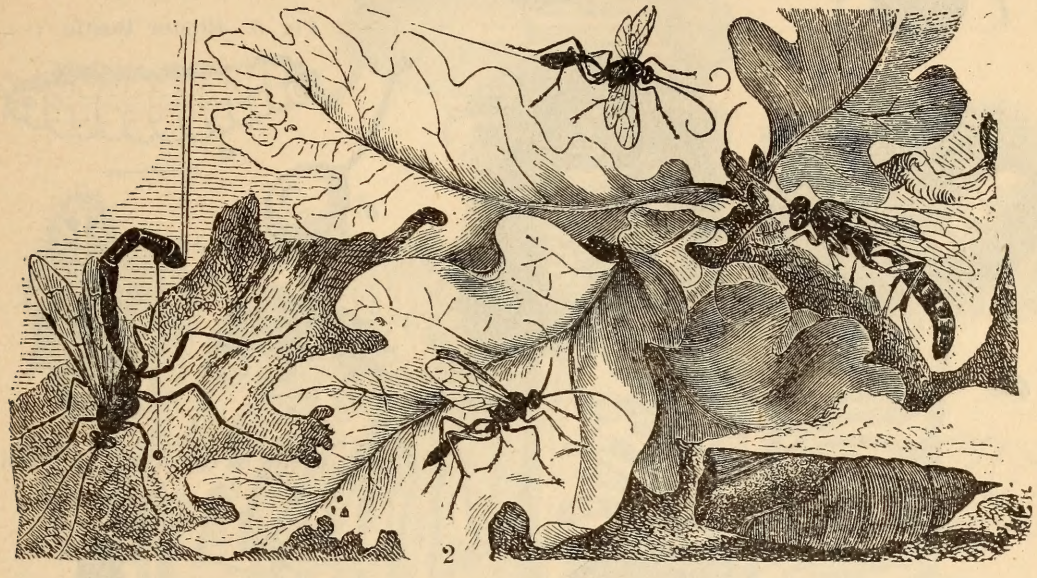


Fig. 2. Ichneumon Flies.

The Hymenoptera contain few noxious species, and as a whole are very beneficial to humanity.

Order II.—Coleoptera, or Sheath-Winged Insects.

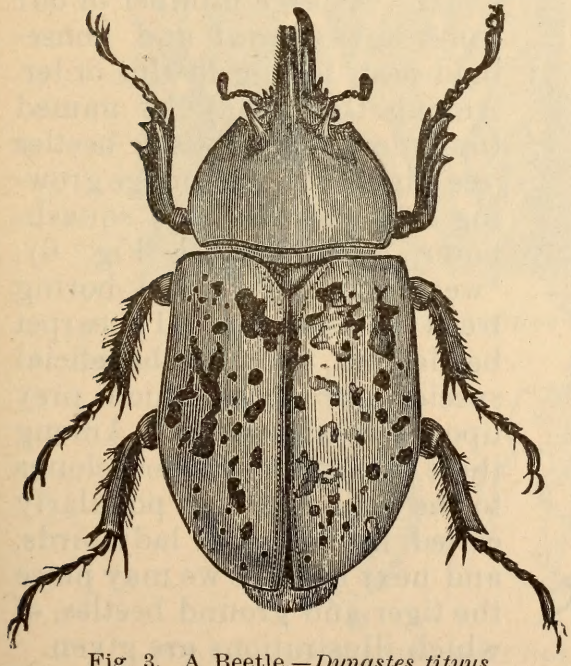


Fig. 3. A Beetle.—*Dynastes tityus.*

This order includes all the sheathed or "hard winged" insects commonly called beetles. (See Fig. 3.) They have a mouth fitted for biting only; they have four wings, of which the front pair are thick and horny, the hind pair are membrane-like, and when the insect is at rest are folded beneath the front pair. The metamorphosis is complete. (See Fig. 4. Imago, larva and pupa.) The larva is called a grub when thick and fleshy, but when slender it is often called a wire-worm or simply "worm." This is considered the largest of the seven orders; the total number of species being estimated at above 200,000. In intelligence and usefulness this order is far inferior to the Hymenoptera. No species of beetles, so far as known are

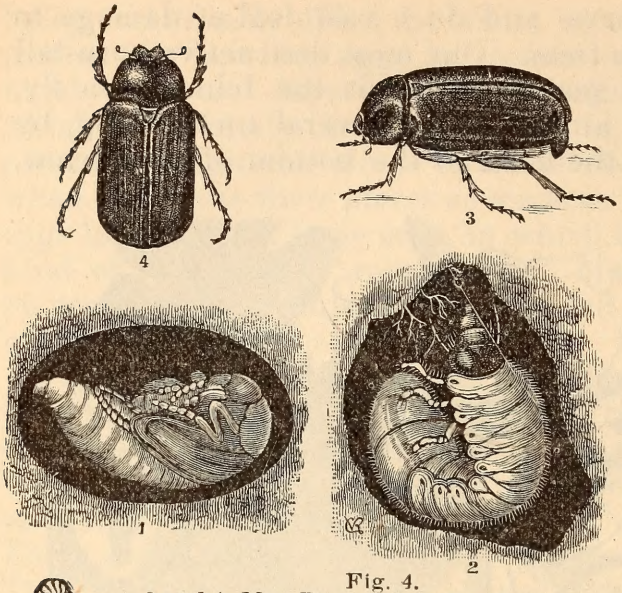


Fig. 4.
3 and 4, May Beetle; 2, larva; 1, pupa.

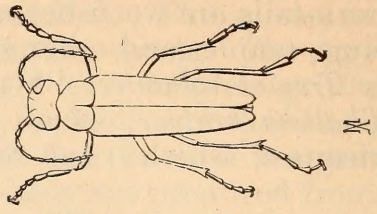


Fig. 5. Blister Beetle.

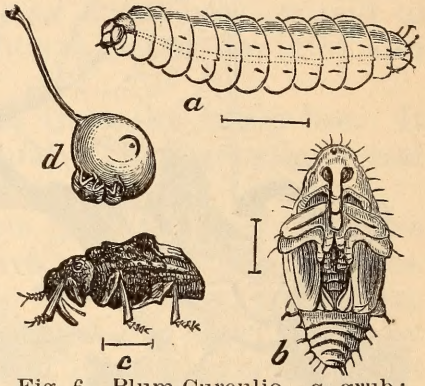


Fig. 6. Plum Curculio. *a*, grub; *b* and *c*, beetle; *d*, egg laying on plum.

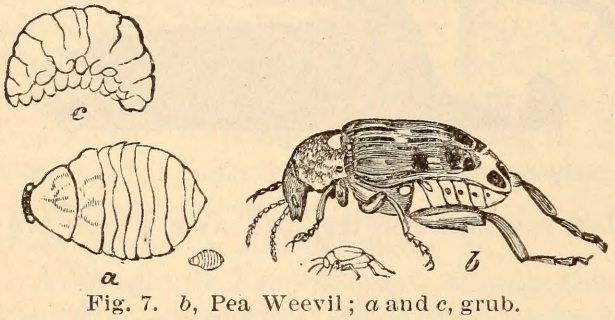


Fig. 7. *b*, Pea Weevil; *a* and *c*, grub.

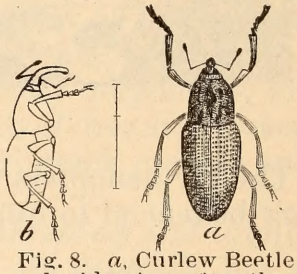


Fig. 8. *a*, Curlew Beetle; *b*, side view of beetle.



Fig. 9. Hazlenut Weevil.

social. A large number of our worst agricultural and household pests belong to this order. Among these may be named the Colorado and blister beetles (see Fig. 5) which damage growing Irish potatoes; the squash-borer, curculios (see Fig. 6); *weevils (see Fig. 7); bark-boring beetles (see Fig. 11); carpet beetles, etc., etc. The beneficial species are those which prey upon noxious species. Among these the place of honor belongs to the little beetles popularly called lady-bugs or lady-birds, and next to these we may place the tiger and ground beetles, of which illustrations are given.

*NOTE.—Where hair lines | —— | are placed near a cut these show exact size of object; where there is no hair line cut is natural size.

The lady-bugs are the natural enemies of plant lice. The larva of the lady-bug resembles a miniature alligator, and its appetite for plant lice is simply amazing. The lady-bugs vary in color and size,

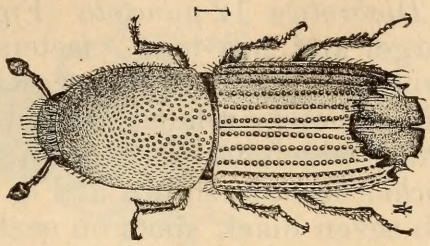


Fig. 10. Bark Beetle.

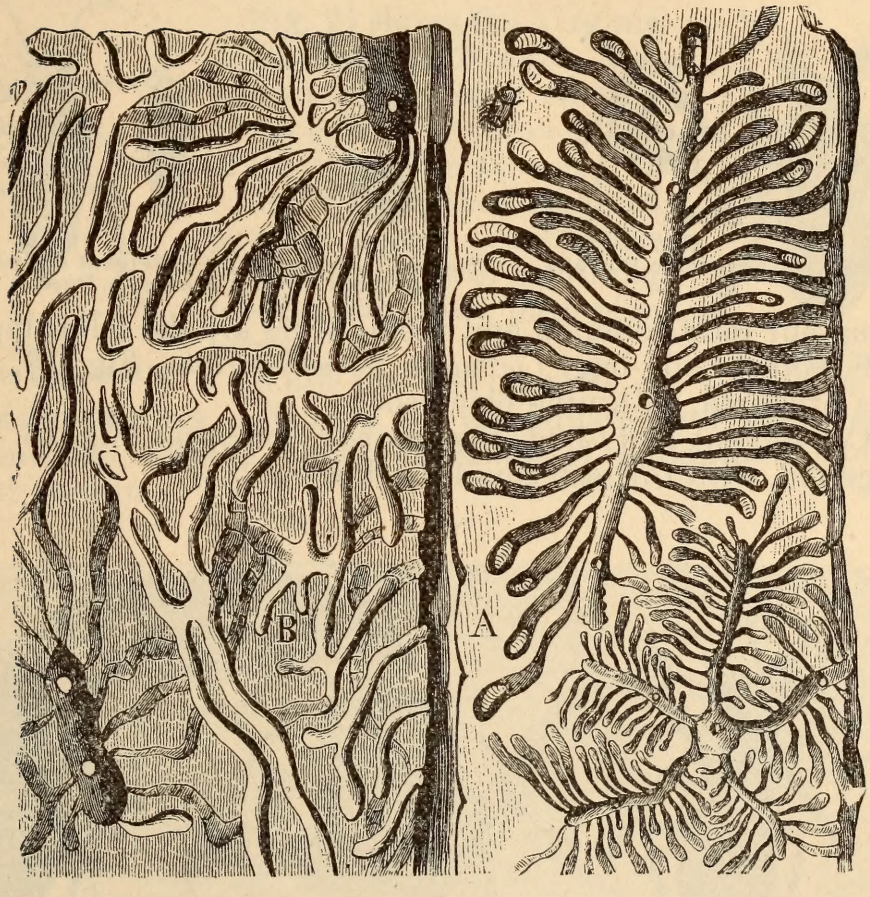


Fig. 11. Burrows of Bark Beetle.

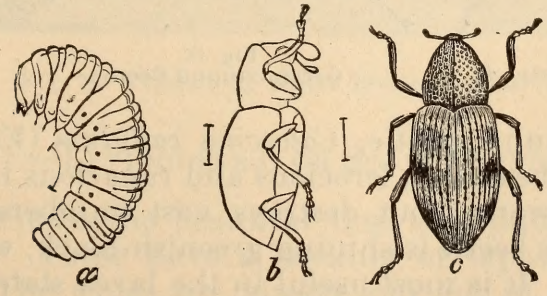


Fig. 12. Corn and Strawberry root borer. *a*, grub; *b* and *c*, beetle.

but they are all small, and the usual colors are red, or pink spotted with black; black spotted with red, and yellow spotted with black.

The noxious cucumber beetle *Diabrotica vittata* may be known from the true lady-bug by its being *striped* instead of spotted. Lady-bugs with us are never striped.

The squash-borer, *Diabrotica 12-punctata* (Fig. 13), resembles a lady-bug, but it is larger and has long "feelers," which lady-bugs have not. The Diabrotica is greenish-yellow, with black spots.

There is another insect closely related to the true lady-bugs (*Coccinella* and *Hippodamia*), which feeds upon cucumber and squash plants. This is *Epilachne borealis*, shown at Fig. 14. It is of a reddish-yellow color, with seven black spots on each wing cover. It is much larger than the true lady-bug.



Fig. 13.
Squash Borer.

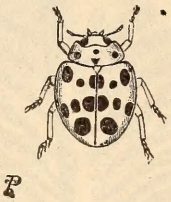


Fig. 14.
Epilachne Borealis.



Fig. 15.
Spotted Lady-bug and larva.

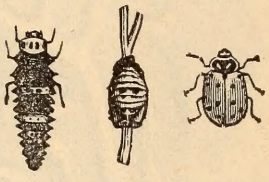


Fig. 16.
Convergent Lady-bug. *a*. Larva. *b*. Pupa. *c*. Adult.

Among our most common and useful allies are the following:

The 9-spotted Lady-bug, *Coccinella novempunctata*, Fig. 15. This beetle is brick-red, with nine black spots.

The Convergent Lady-bug, *Hippodamia convergens*, Fig. 16. This is orange-red, with thirteen small black spots.

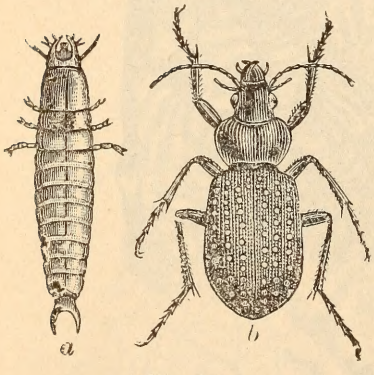


Fig. 17.
The Fiery Ground Beetle (*b*) and larva (*a*).

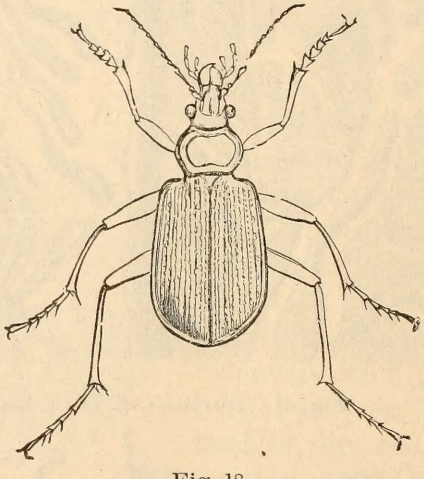


Fig. 18.
Green Ground Beetle.



Fig. 19.
The Murky Ground Beetle.

The Fiery Ground Beetle, *Calosoma callidum* (Fig. 17), is one of our largest, most beautiful, ferocious and rapacious insects. It feeds chiefly upon cut-worms, but destroys vast numbers of cotton and boll-worms. This beetle is shining greenish-black, with golden dots in straight rows. It is most useful in the larva state.

The Green Ground Beetle, *Calosoma scrutator* (Fig. 18), is one of our most common, elegant and useful insects. It is of a shining green color, without spots or stripes.

Figs. 19 and 20 show the Murky Ground Beetle, *Harpalus caliginosus*, and its larva. The beetle is of a blackish color, of the exact size shown.

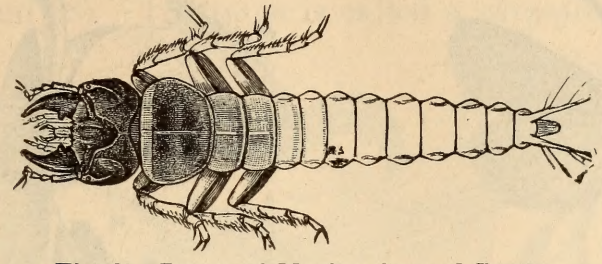


Fig. 20. Larva of Murky Ground Beetle.

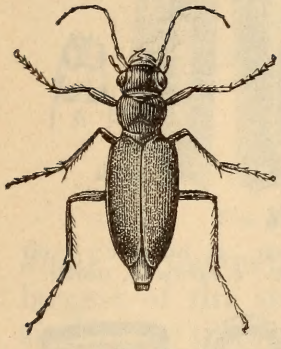


Fig. 21.
Virginia Tiger Beetle.

Fig. 21 shows the Virginia Tiger Beetle (*Tetracha Virginica*). It is of a shining green color, with brown legs, of the exact size shown.

Fig. 22 shows the Elongated Ground-Beetle (*Pasimachus elongatus*). It is of a shining black color, with dark-blue edges.

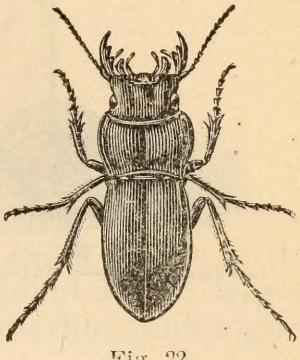


Fig. 22.
Long Ground Beetle.

While the vast majority of beetles are dwellers on land, a few are aquatic and many of these are beneficial, feeding upon the larvæ of mosquitoes and other aquatic vermin.

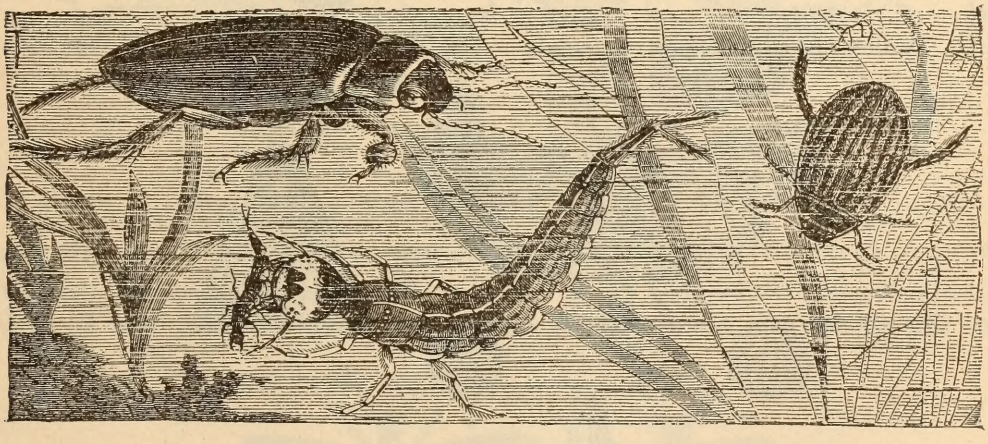


Fig. 23. Predacious Water Beetles and larva.

Order III.—Lepidoptera, or Scale-Winged Insects.

This order includes the beautiful insects popularly called butterflies and moths. These have a sucking or lapping mouth in the winged state. The wings are always four and of the same texture, being covered with scales laid on as shingles on a roof. The metamorphosis is complete.

The two great divisions of this order—butterflies and moths—may be distinguished from each other by the following signs. When at

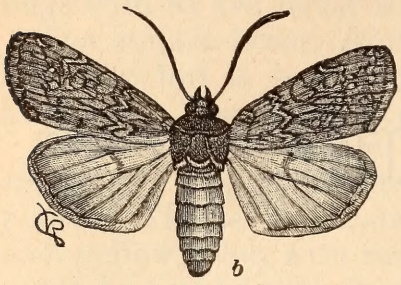


Fig. 24. A Cut-worm Moth.

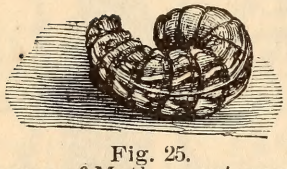


Fig. 25.
Larva of Moth—a cut-worm.

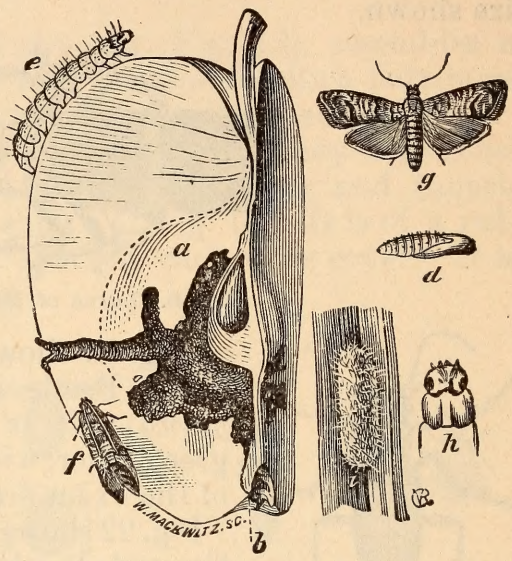


Fig. 26. Codling Moth. *a*, burrow; *b*, entrance hole; *d*, pupa; *e*, larva; *f*, moth.

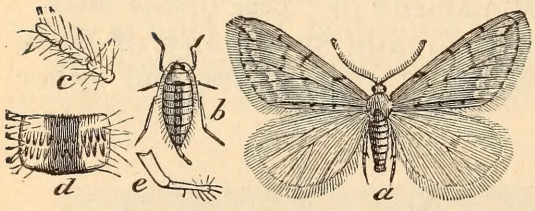


Fig. 27. Canker Moths. *a*, male; *b*, female.

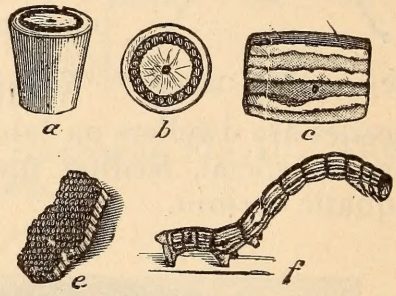


Fig. 28. Canker Worm (*f*), and eggs (*a*, *b*, *e*.)

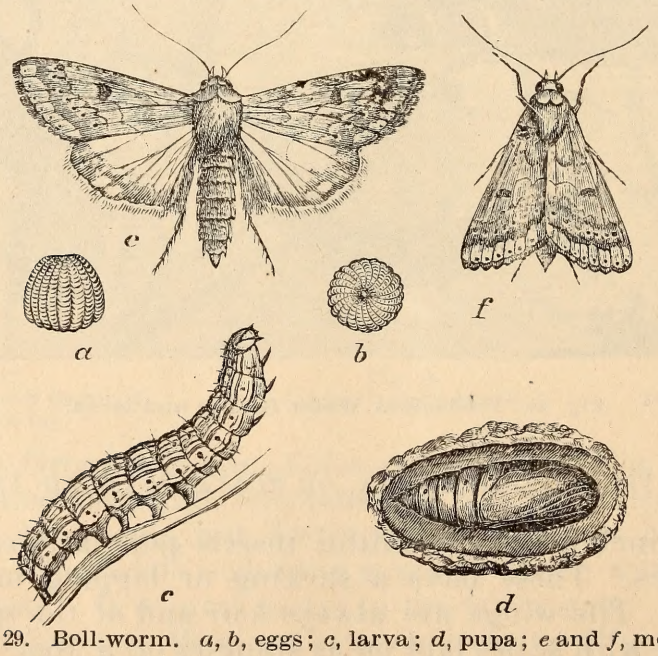


Fig. 29. Boll-worm. *a*, *b*, eggs; *c*, larva; *d*, pupa; *e* and *f*, moth.

rest butterflies hold their wings vertically, so that these are placed back to back, whereas moths at rest hold their wings flat on the body

or sloping downwards like the roof of a house. Butterflies are day flyers and love the bright sunlight; moths mostly fly at twilight. The larva of both moths and butterflies is called a caterpillar (see Figs. 24, 25 and 26). The pupa is called a *chrysalis*, (plural, *chrysa-*

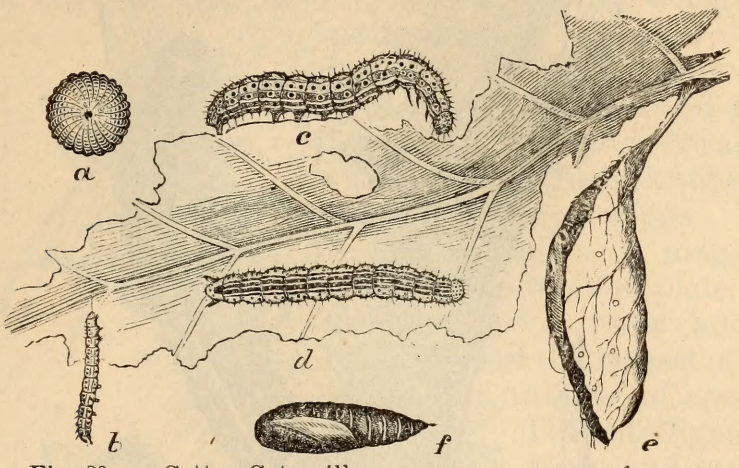


Fig. 30. *c*, Cotton Caterpillar. *a*, egg; *e*, cocoon; *f*, pupa.

lides). The metamorphosis is complete. This order is one of the largest of the seven. The species is most abundant and of largest size in the tropics. Although structurally the butterflies rank higher

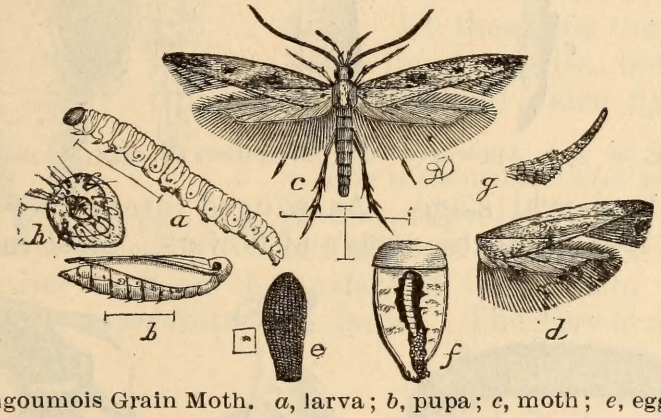


Fig. 31. Angoumois Grain Moth. *a*, larva; *b*, pupa; *c*, moth; *e*, egg; *f*, burrow.

than the moths, the latter division of the order is the most important from an economic standpoint—it includes the useful silkworms and some of our most destructive agricultural pests. Among the latter

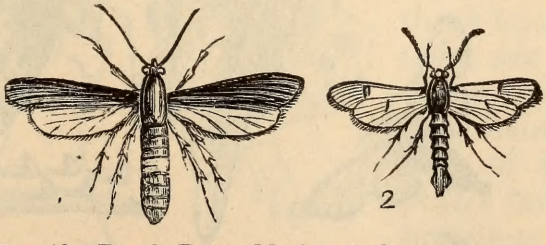


Fig. 32. Peach Borer Moths. 1, female 2, male.

we may name the codling moth (Fig. 26), canker-worm moths (Figs. 27 and 28), boll-worm moth (Fig. 29), cotton worm (Fig. 30), tobacco moth Angoumois grain moth, (Fig. 31), peach borer moth, (Fig. 32) and cut-worm moths, of which there are several species.

Among the butterflies the most injurious genus is the white and yellow cabbage butterfly, *Pieris oleraceæ*. All Lepidoptera do their

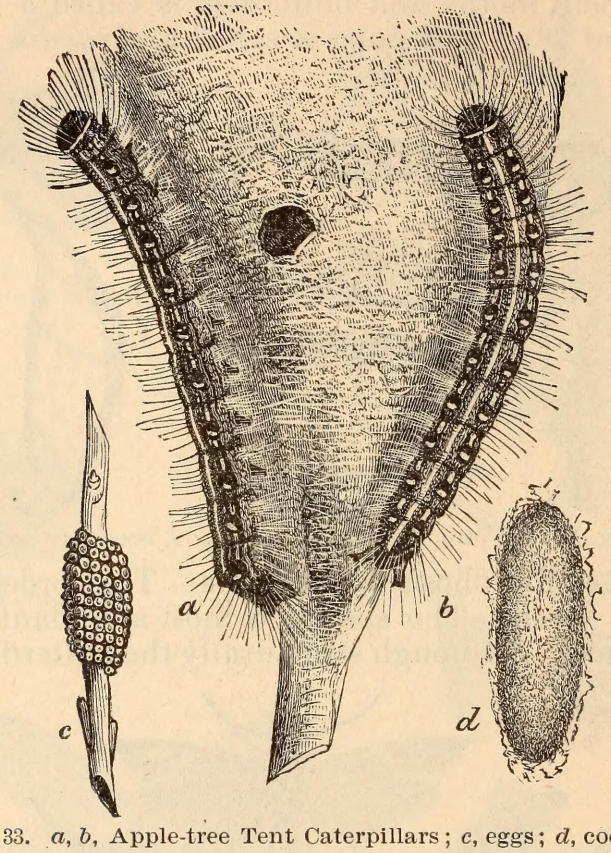


Fig. 33. *a*, *b*, Apple-tree Tent Caterpillars; *c*, eggs; *d*, cocoon.

damage in the larval stage. As winged insects they either do not feed at all or feed upon the nectar of flowers. Most caterpillars live

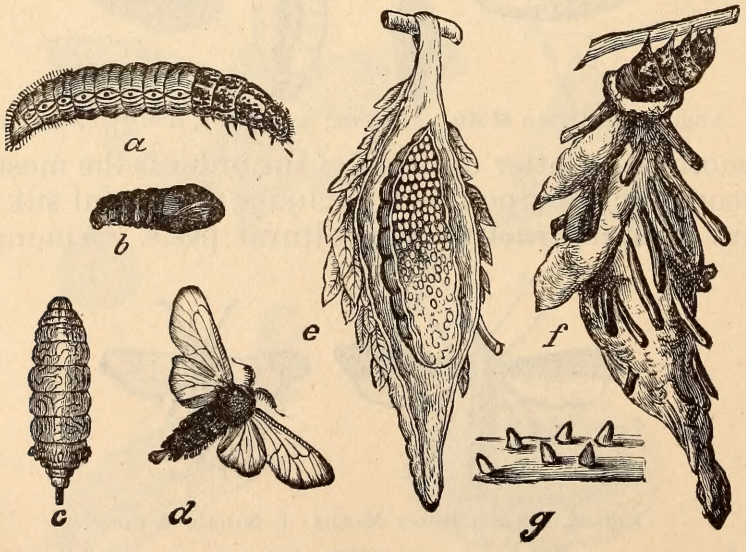


Fig. 34. *a*, Bag-worm of Pear Tree; *d*, moth; *e*, eggs; *f*, worm in bag.

without shelter of any kind—a few species construct nests or tents and some a sort of movable bag or case. (See Figs. 33, 34).

Order IV.—Diptera, or Two-Winged Insects.

This order includes the two-winged insects commonly called flies. The mouth parts of flies are fitted for piercing and sucking only. They do not chew or tear their food as do beetles, but most of the species have a very sharp lancet, by means of which they pierce the skin of men and animals and then suck the blood. The wings are always two, with a pair of little knobs on short stems behind the wings. The larva of flies is called a maggot. The metamorphosis is complete. (See Fig. 35—egg, larva, pupa and imago.) This is one of the largest of the seven orders, the number of species being very large. The intelligence of this order is not high, and many of the most degraded parasitic forms belong to it. In an economical sense it is very important, as it includes some of our most troublesome insect enemies. Of these we may name the house fly, mosquito, bot fly, warble fly, Hessian fly, horn fly, and many more.

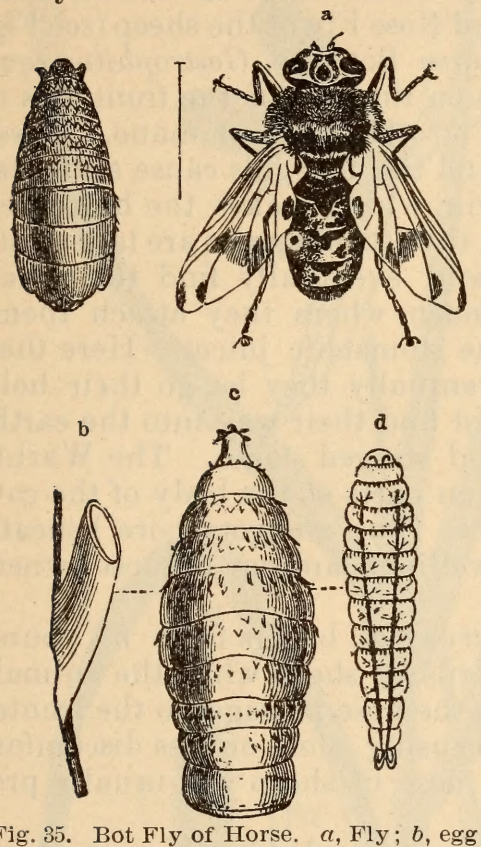


Fig. 35. Bot Fly of Horse. *a*, Fly; *b*, egg; *c* and *d*, larva; *e*, pupa.

The mosquito, *Culex pipiens* and *C. ciliatus*, is probably the most notorious of these pests (see Fig. 36). This insect deposits her eggs on the surface of stagnant or still water—usually in ponds, reservoirs and tanks. The larvæ are the well-known "wrigglers" or "wiggle-tails" seen in rain-water barrels which are allowed to stand exposed to the air. The female mosquito lays about three hundred eggs, and there are probably half a dozen generations in a year, hence the vast numbers of these pests in places favorable for their breeding. In justice to masculinity in general, it should be noted that the obnoxious mosquito and all blood-sucking flies generally are all *females*—the males usually live in retired places upon the nectars of flowers. It has been found that a very little

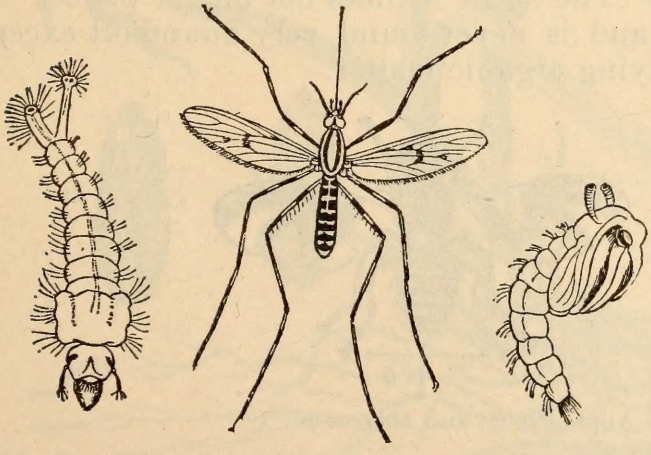


Fig. 36. Mosquito, larva, and pupa (magnified).

kerosene poured over the surface of ponds, tanks, etc., wherein mosquitoes breed will destroy the eggs and larva, thus freeing the vicinity of the undesirable presence of the adult female.

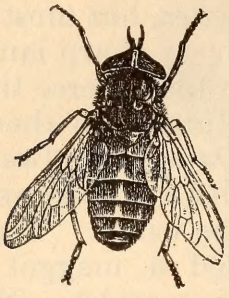


Fig. 37. Gad Fly.

Among the most troublesome flies are the Bot Fly of the horse, Gad and Warble Flies of the cow, and Nose Fly of the sheep (see Fig. 37). The Horse Bot Fly, *Gastrophilus equi*, lays her eggs on the hair of the front legs of the horse or on the sides or mane. These soon hatch, and the maggots cause an irritation of the skin, which makes the horse lick the spot, and thus the maggots are taken into the mouth, and eventually find their way into the stomach, where they attach themselves to the walls and feed upon the stomachic juices. Here they remain for about nine months. Eventually they let go their hold and pass out with the excrement, and find their way into the earth, where they transform to the pupal and winged stages. The Warble Fly, *Hypoderma bovis*, lays her eggs on parts of the body of the cow where the animal cannot reach them. The maggots bore beneath the skin, producing the sores and swellings familiar to most owners of cattle.

The Sheep Bot, or Nose Fly, *Œstrus ovis*, brings forth its young alive and deposits them in the nostrils of sheep while the animals are grazing. The maggots crawl up the nose passages to the frontal cavities, where they fix themselves, causing more or less discomfort and often death. Fresh tar on the nose of sheep will usually prevent the entrance of the grub.

The common house fly is *Musca domestica*. It lays its eggs, about seventy-five in number, on manure piles or decaying filth of any kind, upon which the maggots feed until ready to transform to the pupal and winged stages. The house fly does not bite or pierce. It is useful as a scavenger and is never found very abundant except where there is much decaying organic matter.

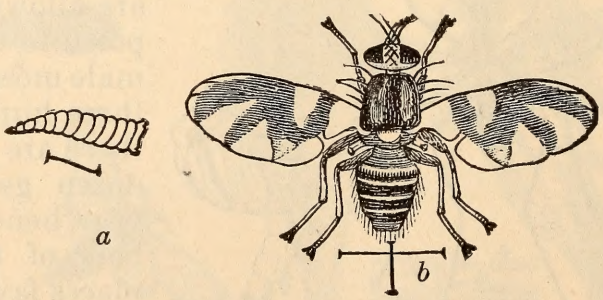


Fig. 38. Apple Fly (*b*) and Maggot (*a*).

Of outdoor agricultural pests, the worst in this order is probably the apple maggot, *Trypeta pomonella*, (see Fig. 38), and Hessian Fly (Fig. 39), *Cecidomya destructor*, a pest introduced from Europe with straw brought over by the Hessian mercenaries employed by the

English in the Revolutionary war. The Horn Fly, *Hæmatoba serrata* (Fig. 40), is a more recent importation from Europe, and is



Fig. 39. Hessian Fly; larva, pupa, and its parasite, *Semiotellus destructor*. *a*, egg; *b*, maggot; *c*, pupa case; e, *f*, female fly; *g*, male; *h*, position of maggot in wheat plant; *i*, parasite of Hessian fly.

now very annoying to cattle. The insects which produce the curious excrescences on oak trees, rose bushes, and many other plants, belong

to this order. The common gall-fly of the rose is *Rhodites rosæ* (Fig. 41). The Flea (Fig. 41a), *Pulex irritatans* and other species, also belong to this order.

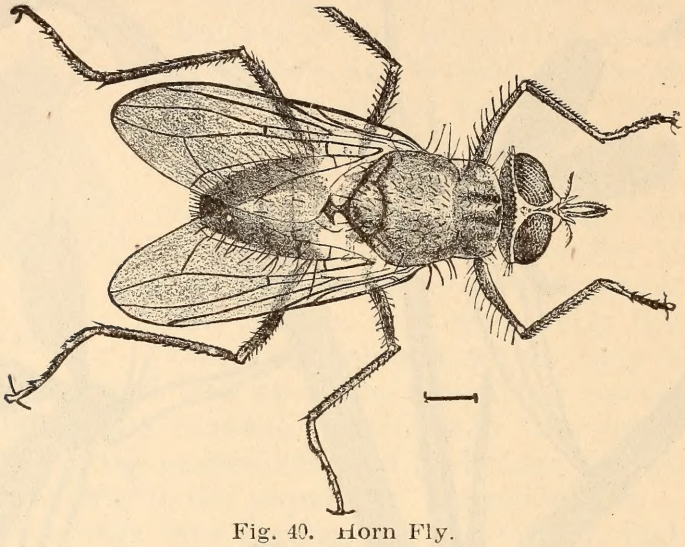


Fig. 40. Horn Fly.

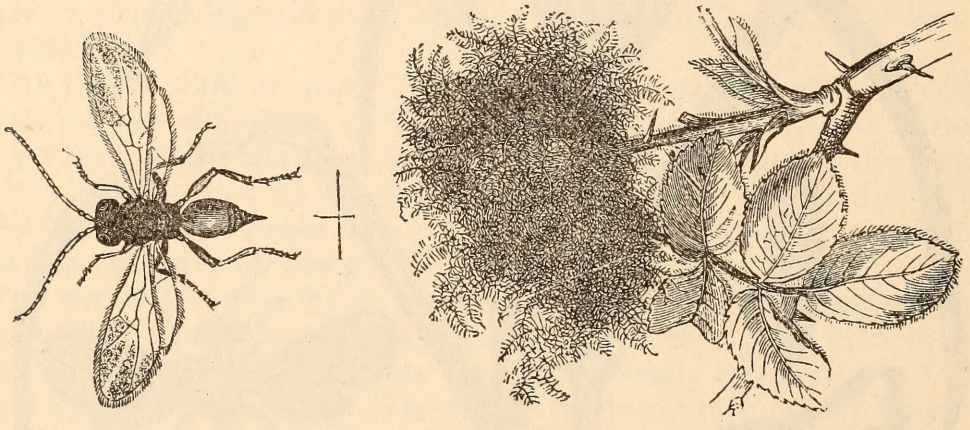


Fig. 41. Gall Fly and gall of the Rose.

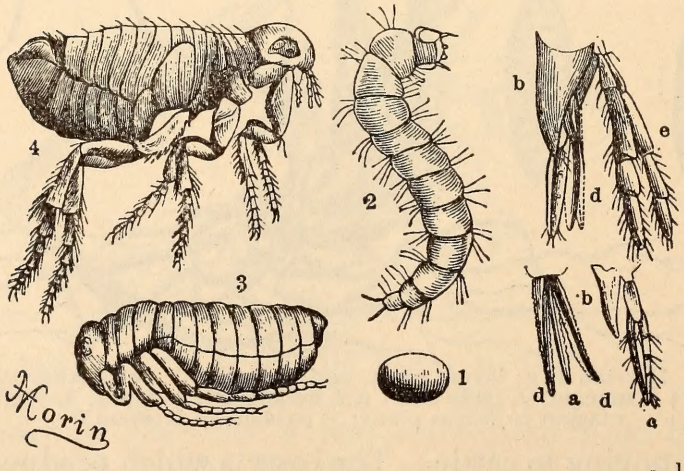


Fig. 41*a*. Flea (magnified). 1, egg; 2, larva; 3, pupa; 4, adult.

Order V.—Hemiptera, or Half-Winged Insects.

This order includes the periodical cicada and all the true bugs—chinch bug, squash bug, bed bug, and others having a similar unpleasant and characteristic odor. By some people all insects are called "bugs," but this is a misuse of words. The term "bug" should be restricted to half-winged insects, just as "beetle" is to the sheath wings. The mouth parts of true bugs are fitted for piercing and sucking only, being modified to form a sharp beak called the *rostrum*. The wings are four in number. The parts of the wings nearest the body are of a thick leathery texture, while the part towards the tips is membrane-like—hence the name half-wings. The Hemiptera are not a very large order, but include some of the most destructive of agricultural pests, as well as the most degraded

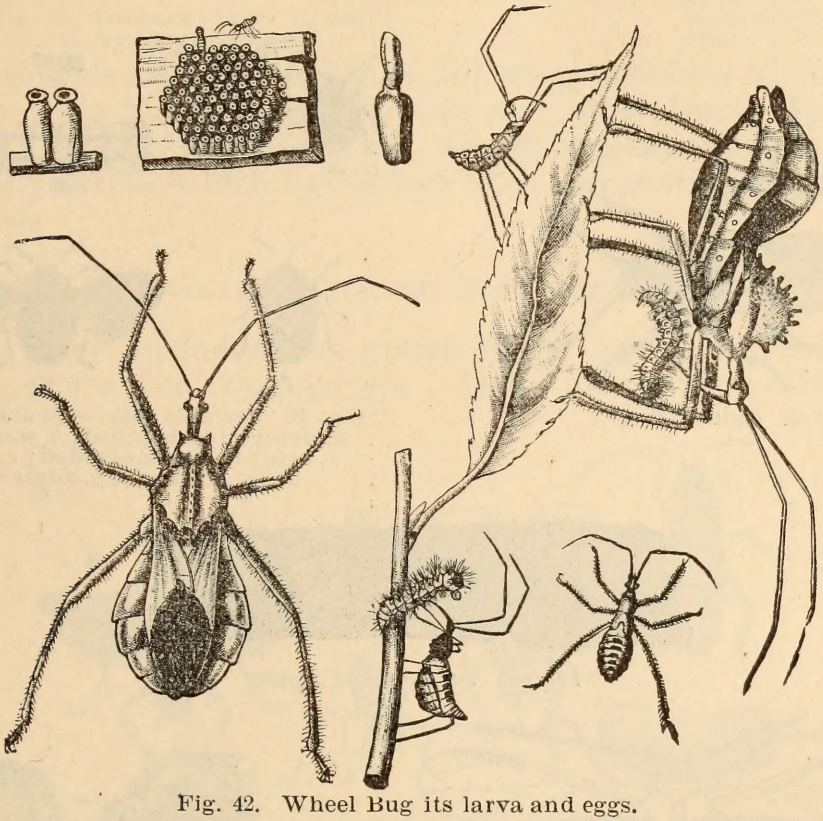


Fig. 42. Wheel Bug its larva and eggs.

and loathsome of known insects. The metamorphosis of bugs is incomplete. That is to say, the young do not pass through the cycle of changes, such as the beetles, flies, and bees do. The young bugs are hatched from eggs, but resemble the parents as soon as hatched, and do not make any sudden or considerable change in appearance while growing. They merely cast their old skins three or four times, and at each moult slightly change color and marking. They increase in size, but do not have wings until maturity. The young of bugs are called *nymphs*. A large number of species of this order are aquatic, and a few are predacious and benefit agriculture by destroying other insects. Among the useful bugs may be mentioned the

Wheel Bug, *Prionotus cristatus* (see Fig. 42); the Thick-thighed Soldier-bug, *Acanthocephalia femorata* (see Fig. 43), and the Banded Bug, *Milyas circinata* (Fig. 44). The Lac insects of the East Indies,

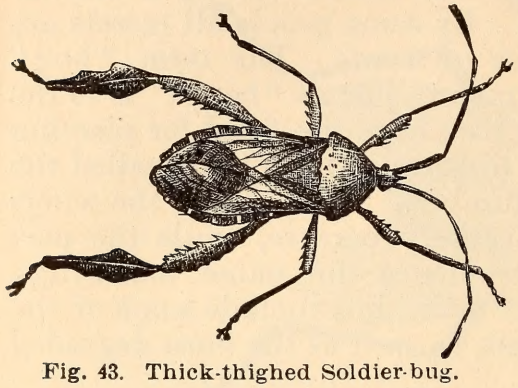


Fig. 43. Thick-thighed Soldier-bug.

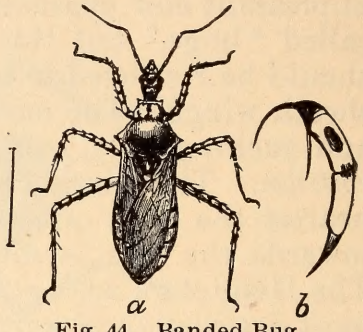


Fig. 44. Banded Bug. *b*, beak magnified.

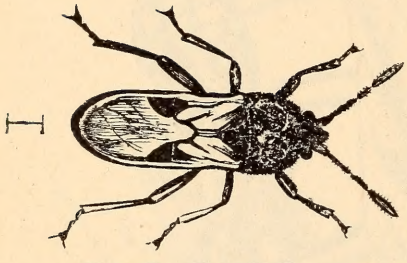


Fig. 45. Chinch Bug.

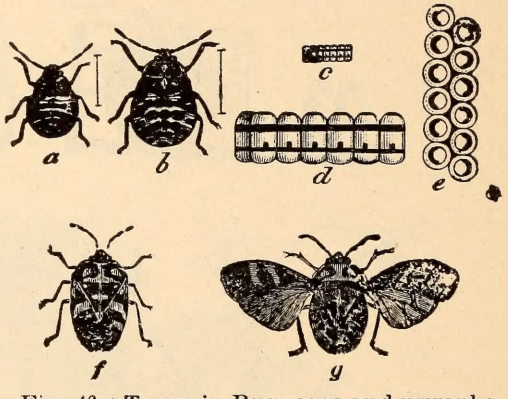


Fig. 46. Terrapin Bug, eggs and nymphs. *a*, nymph just hatched; *b*, same older; *c*, eggs; *d*, eggs magnified; *e*, section of egg cluster; *f*, *g*, adult bugs.



Fig. 47. Scale-bug of Apple.

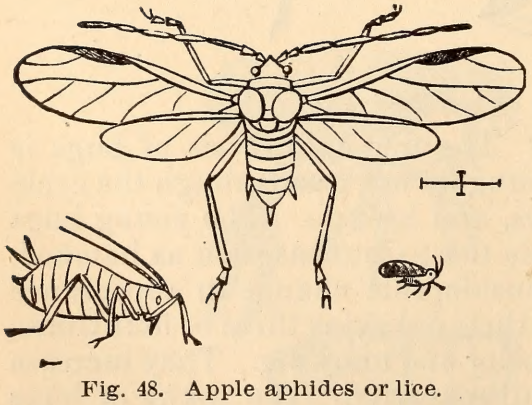


Fig. 48. Apple aphides or lice.

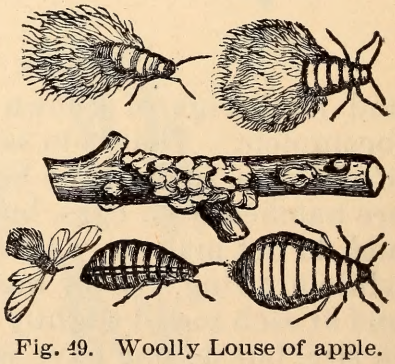


Fig. 49. Woolly Louse of apple.

Carteria lacca, and the Cochineal insect, *Coccus cacti*, of Mexico, are true bugs. So, also, are the scale insects of our orchards and plant lice generally.

Among the most degraded Hemiptera are the head and body lice of men and beasts. These insects by parasitic degradation have lost their wings. The head louse of man is *Pediculus capitis* (see Fig. 51); that of the body and clothing is *P. vestimenti*. Among our most

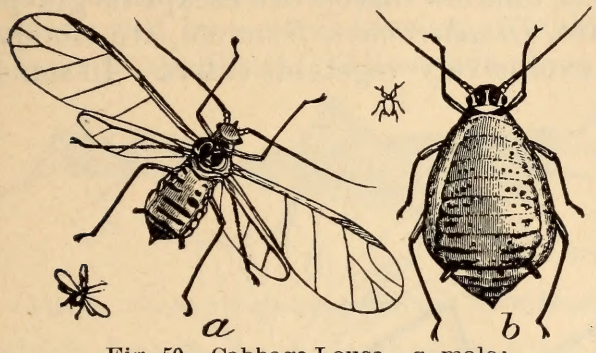


Fig. 50. Cabbage Louse. *a*, male; *b*, female—magnified.

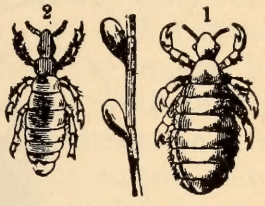


Fig. 51. Louse of man (magnified). 1, head-louse; 2, body louse.

injurious pests may be named the following members of this order: bark, or scale bugs of apple, orange and other trees; Aphides, or plant lice proper; the chinch bug, squash bug, terrapin bug, and the grape phylloxera, which has caused such devastation in European vineyards.

Order VI.—Orthoptera, or Straight-winged Insects.

This order includes the grasshoppers, crickets, locusts, cockroaches, and a few other genera. These insects have a biting and

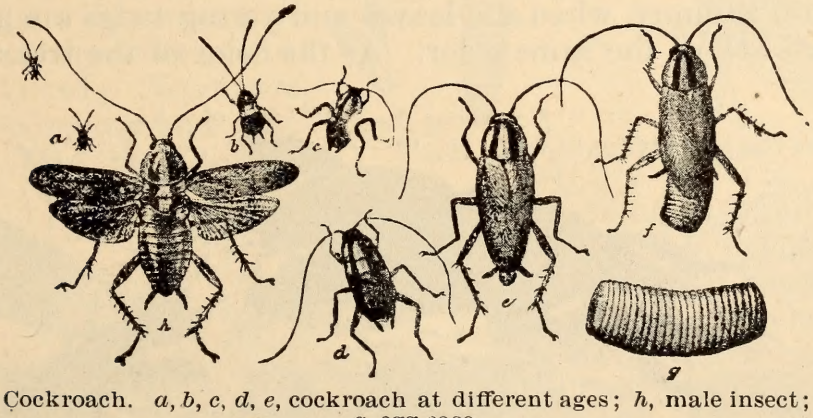


Fig. 52. Cockroach. *a*, *b*, *c*, *d*, *e*, cockroach at different ages; *h*, male insect; *f*, female; *g*, egg case.

gnawing mouth, and four wings which are parchment-like or membrane-like with straight veins. The metamorphosis is incomplete—the young resemble the parents and there is no quiescent or true pupal stage. The immature form in this order is called a nymph. This is the smallest of the seven orders, and is also the oldest, being the earliest insects whose remains are found preserved in the ancient sedimentary rocks of the earth. It is most abundant in dry regions. This order is for the most part noxious—the locusts and grasshoppers being terrible devastators in dry climates, and more or less troublesome everywhere. The cockroaches are well known and very

offensive pests of the household. One genus, *Mantis*, is exclusively carnivorous and feeds upon various noxious species, and is, therefore, useful (see Fig. 53). The most common species is *Mantis Carolina*, popularly called rear-horse, devil's riding horse, and praying mantis. It is very ferocious, and few insects can escape its grasp. The Walking Sticks, or Spectres, *Diapheromera femorata*, are closely related to the Mantis, but are exclusively vegetable eaters. In some

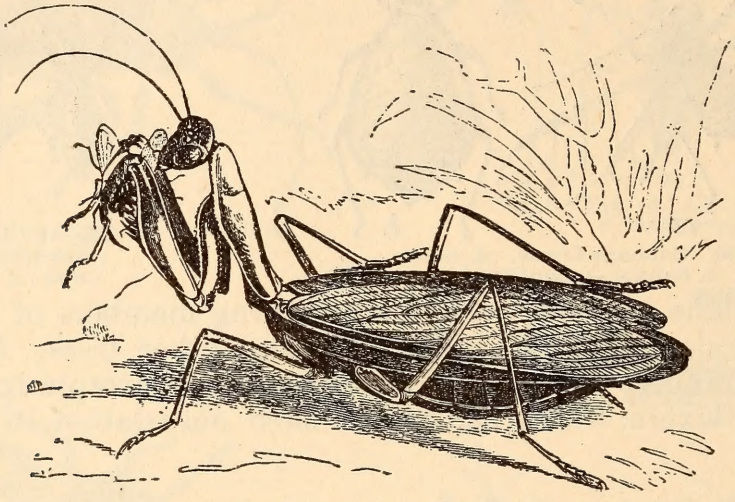


Fig. 53. Praying Mantis.

seasons they are very destructive to the foliage of oaks. These insects are protected from carnivorous insects and birds by their resemblance to the twigs of the trees upon which they feed. In spring and summer, when the leaves and young twigs are greenish, the insects are of the same color. As the color of the tree changes,

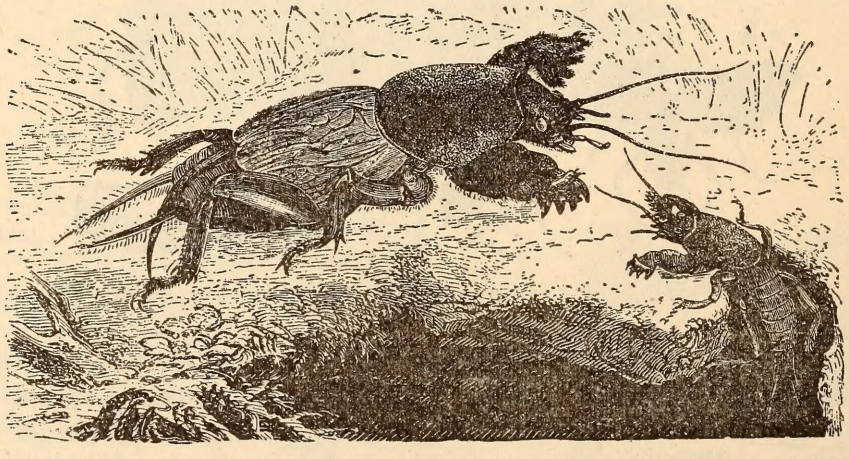


Fig. 54. Mole Cricket.

the color of this insect changes likewise. Most Orthoptera live above ground, but one genus—the mole cricket—is a burrower and lives under ground (see Fig. 54). There are several species of these, but our common mole cricket is *Gryllotalpa longipennis*. This insect eats earth-worms and the larva of other insects which come in its way

while burrowing, but its principal food is the roots of plants. The house cricket, *Gryllus domesticus*, is a European insect celebrated by poets for its connection with the domestic hearth. The snowy tree cricket, *Œcanthus niveus*, does much damage to blackberry and raspberry canes by depositing its eggs in them. The noisy katydid is represented by several species, of which the most common is *Cyrtophyllis perspicillatus*. These live upon trees and shrubs and are most active about twilight during June, July and August. The sounds are made by special organs on the wings and are supposed to be serenades to their mates. The Rocky Mountain Locust, which does so much damage in our far Western States, is *Caloptenus spretus*. The most common species in the Atlantic States is *Caloptenus atlantis*. The "Locust" of the Bible is probably *Pachytylus migratorius*, an Asiatic and African species which is not found in America.

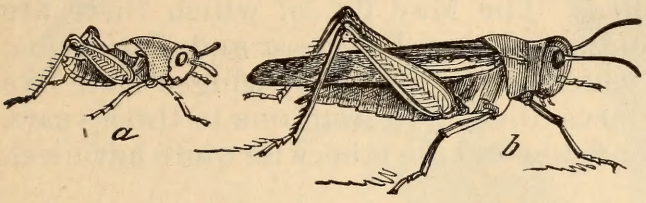
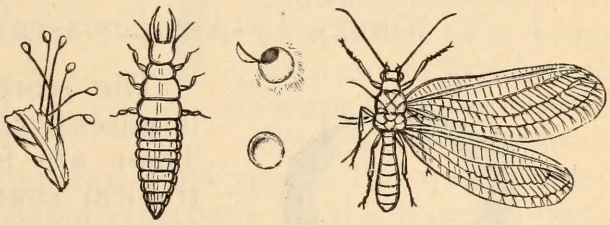
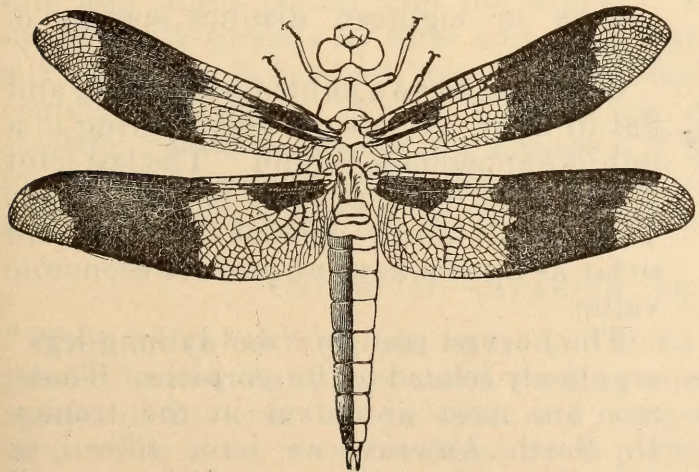


Fig. 55. Eastern Grasshopper (*b*) and Nymph (*a*).

Order VII.—Neuroptera, or Nerve Winged Insects.

This order includes the dragon-fly, or "Snake Doctor" (see Fig. 56), the Dobson or hellgramite fly, the predacious and useful lace-wing fly (see Fig. 55), May fly, book lice, white ants or *Termites*, and others. By some authors this order is divided into three orders, called respectively *Neuroptera*, *Pseudo-neuroptera* and *Thysanura*. The mouth parts are fitted for biting and gnawing. These have four wings, except in the degraded species, which have lost their wings. The metamorphosis is incomplete. This is one of the smallest of the seven orders, and is of the least importance from an economical standpoint. The most destructive of this order of insects are the "white ants," *Termes flavipes*, *T. arborum*, and other species. These are not true ants, which belong to the Hymenoptera, the highest order of insects, as these to the lowest order. The white ants are wood-boring


Fig. 55. Lace-wing Fly, Eggs and Larva.


Fig. 56. Dragon Fly.

insects and often bore into and destroy the timbers of houses, furniture and anything made of wood. They are most abundant and troublesome in the tropics. Our species is *T. flavipes*, which is more commonly found in decaying pine stumps than in houses.

The common Dragon Fly, *Libellula tri-maculata*, is a very useful insect, as it feeds almost wholly upon mosquitoes and their larvæ. It is entirely harmless to men and the larger animals and should never be injured or persecuted. The May fly, of which there are several genera, the most common being *Ephemera* and *Palingenia*, are delicate aquatic insects which in the perfect or winged state live but a few hours. But as larva these live from one to three years. These insects furnish food for fishes and are otherwise quite harmless.

SUBCLASS ARACHNIDA.

This subclass includes spiders, scorpions, harvestmen and mites. These insects are distinguished from Hexapods by having eight legs instead of six. The head and trunk are also united in one piece called the *cephalo thorax*. Antennæ or "feelers" are absent. All this subclass of insects have simple eyes. There is no metamorphosis. The scorpions bring forth their young alive. The total number of species included in this subclass is between 5,000 and 6,000, divided into three natural orders.

Order I.—Arthrogastra, or Scorpions.

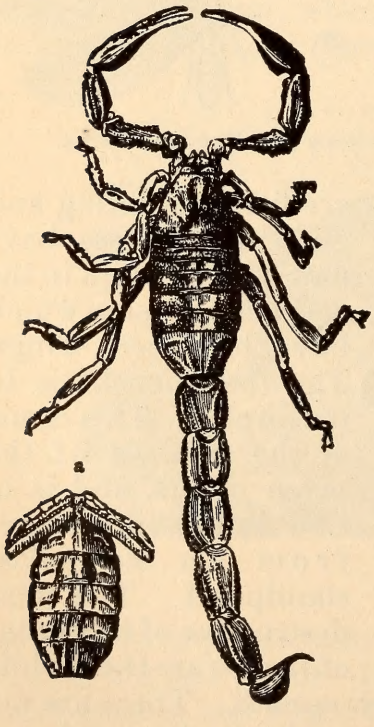


Fig. 57. Scorpions.

The scorpions (see Fig. 57) are the highest representatives of this order. These are found most abundantly in tropical countries. The total number of species is probably three hundred to four hundred. In North America we have sixteen or eighteen distinct species of scorpions.

Scorpions have a jointed body broad and flat in front, but narrow and tapering to a tail-like appendage behind. The last joint is armed with a sting and poison glands. They are all most venomous creatures, and so far as known have no positive economic value.

The harvest-men, or "daddy long-legs" are closely related to the scorpions. These, too, are most abundant in the tropics. In North America we have fifteen or twenty species. All our species are small and all are carnivorous, feeding upon smaller insects and are useful and harmless to mankind.

Order II.—Araneina, or Spiders.

All the spiders have eight legs, eight eyes, a biting mouth and the body divided into two parts. At the end of the abdomen are three pairs of spinnerets which produce the threads which form the web. (See Fig. 58.) There is no metamorphosis. The female is always larger than the male. The female usually lays her eggs at night and covers them with a silken case or cocoon. Some species carry this cocoon around with them until the eggs hatch, which they do in a few days. The young spiders eat their way out of the cocoon. Often they eat one another, so that out of a brood of a dozen only one or two live to escape from the cocoon. Spiders live in webs in houses, in holes in the ground, and a few species live under water in air-tight nests constructed like diving-bells. All are carnivorous and live upon insects—more especially flies. They do not sting, but bite and inject poison into the wound. The webs of spiders are made of silk threads far finer and more lustrous than those of the silkworm, but it has been found impracticable to use it. The most common genera in North America are *Attis*, *Tarantula*, *Epeira*, *Nephila*, *Theridion*, *Atypus* and *Erigone*. Tropical countries have the giant and venomous genus, *Mycale*, which kills and eats birds. Altogether we have about 800 species of spiders.

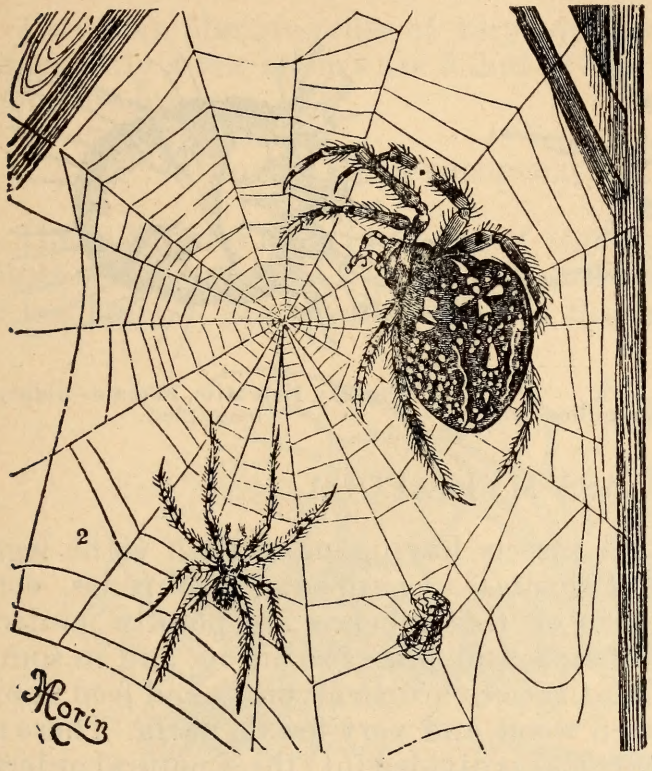


Fig. 58. Diadem Spider. 1, female; 2, male.

Order III.—Acarina, or Mites.

This order contains the mites and ticks. These have obscurely jointed bodies, eight legs, and a sucking and piercing mouth. Most species of this order are parasitic and more or less degraded in structure. The mite most troublesome to plant growers is the so-called "Red Spider," *Tetranychus telarius* (Fig. 59).

The disease called itch in men is caused by a species of mite (see Fig. 60), *Sarcoptes scabei*. *S. canis* produces the mange of dogs, and other animals have their characteristic species. Bats, birds and

poultry are very subject to parasitic mites. A few species are parasitic on fishes. "Texas fever" and "anthrax" in cattle are diseases transmitted and disseminated by ticks—species of *Ixodes*. These ticks cause an annual loss of several millions of dollars to the people of the Southern States.

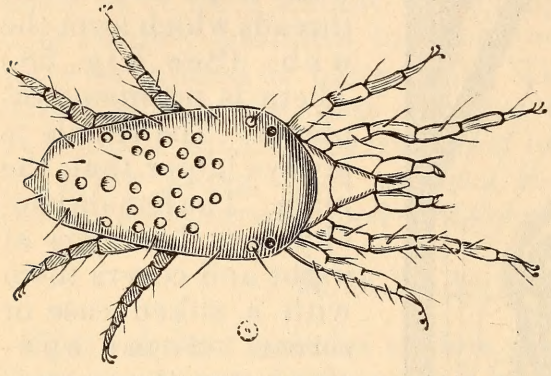


Fig. 59. "Red Spider" Mite—magnified.

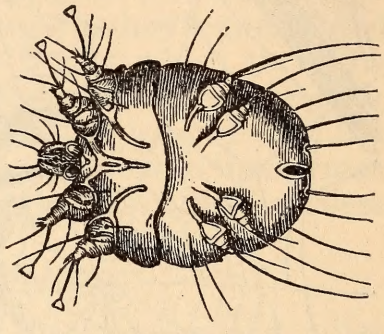


Fig. 60. Itch Mite, Female—highly magnified.

SUBCLASS MYRIAPODA.

This subclass includes all insects having more than eight legs, except the single genus, *Peripatus*. Centipedes, millipedes, etc., belong here. All the insects of this subclass are plainly jointed, have distinct heads with antennæ and jaws for biting, and in some species also for sucking. Most species are carnivorous and feed upon small insects; some eat rotten wood, and very few do harm. There is no metamorphosis. The subclass is divided into three natural orders.

Order I.—Chilopoda, or Centipedes.

Centipedes are flesh eaters and very active (see Fig. 61). Some species are venomous. All have one pair of legs for each joint of

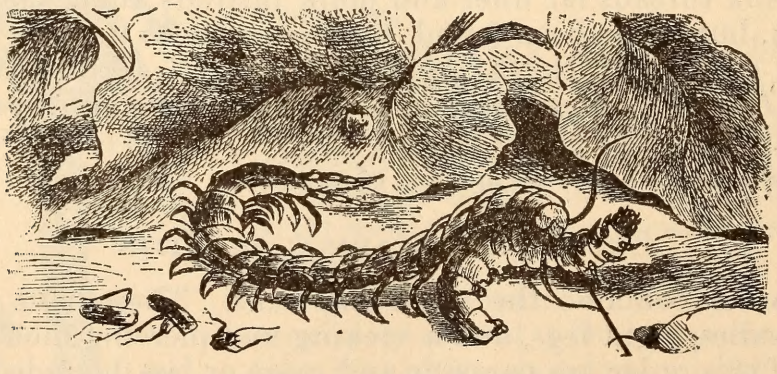


Fig. 61. Centipede—one-half size.

the body. They are largest and most abundant in the tropics. *Scolopendra gigantea* and *S. morsitans* are the celebrated poisonous centipedes of the Indies and South America. The largest species in the United States is *Scolopendra castaniceps*, more or less common in

the Gulf States. *Cermatia forceps*, a smaller and non-poisonous species, is common in the Carolinas.

Order II.—Pauropida.

This is an obscure order of very small semi-aquatic centipedes, of which only a few species are found in the United States. It has no economic interest.

Order III.—Diplopoda, or Millipedes.

The millipedes have two pairs of legs on all except the first three joints of the body (see Fig. 62). The body is cylindrical and more or less hairy. The mouth parts are fitted for sucking and biting.

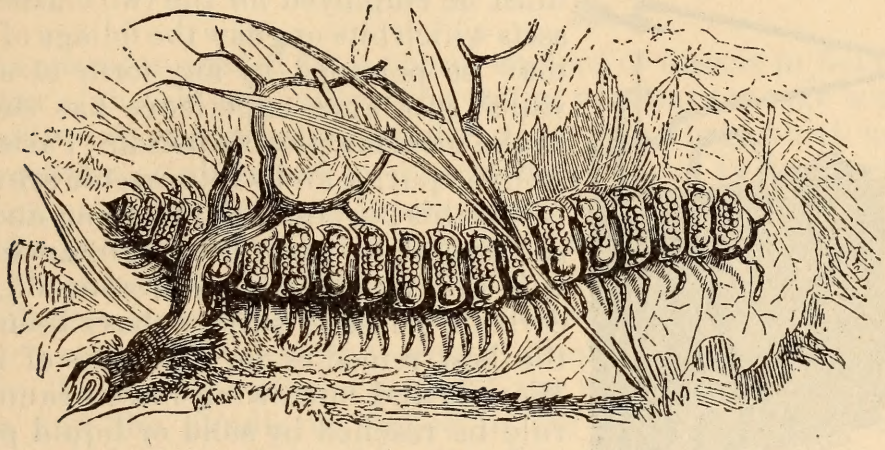


Fig. 62. Millipede—magnified.

The eyes are simple or absent. This order is not venomous. Our most common species of millipedes belong to the genus *Iulus*, often called galley-worms. These feed chiefly upon rotten wood and such dead insects as come in their way. These are sometimes found on scabby potatoes, but are not the cause of the scab. They are of little or no economic interest.

SUBCLASS MALACOPODA.

This subclass includes but a single and very singular genus, *Peripatus*, found only at the Cape of Good Hope in Africa, and New Zealand. These insects resemble millipedes and true worms. They are supposed to be the last surviving form of the ancestral type of all our modern insects. They have no other interest.

HOW TO COMBAT NOXIOUS INSECTS.

The scientific classification of insects has been given in the preceding pages. For economic purposes a different classification is to be preferred. Insects may be classified as beneficial, harmless and noxious. We have to deal here only with the third class. This may be further subdivided into (1) biting and gnawing insects; (2) sucking and piercing insects. Different methods of destroying these insects must be employed for the two classes. Insects which bite or gnaw the foliage of plants may be poisoned by any form of arsenic, which substance experience has shown to be the most practicable poison. Paris green, London purple and white arsenic are all useful for this purpose. For piercing and sucking insects, we must use a substance which will kill by contact. Kerosene oil, crude carbolic acid and sulphur have been found the best remedies for this class of insects. Weevils and burrowing insects cannot as a rule be reached by solid or liquid poisons, and against such we must use gases. The most useful poison for this purpose is produced by volatilization of bisulphide of carbon and cyanide of potassium. Sulphur fumes are especially valuable against ticks and mites. Air-slaked lime, soot, or fine powder of any kind, is often succes-ful in killing insects—especially fat, sluggish grubs. These act by clogging up the breathing holes of the insects and smothering them. Persian Insect Powder, made from the flowers of species of *Pyrethrum*, a plant of the Aster family, is sold by most druggists, but is very unreliable for outdoor use. It stupefies the insects for a time and they fall to the ground as if dead, but nearly all recover after a brief period. A few insects seem proof against all practicable poisons, and these must be hand picked when

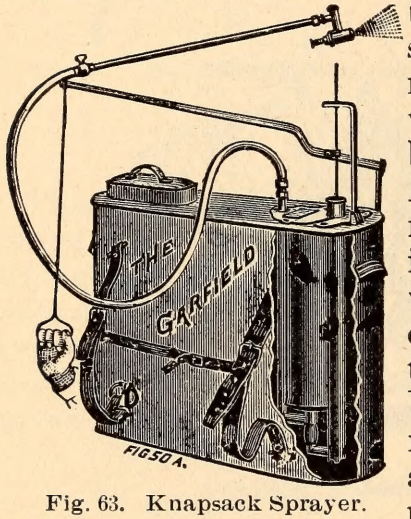


Fig. 63. Knapsack Sprayer.



Fig. 64. Barrel Sprayer.



Fig. 65. Powder Bellows.

they are too abundant. A fuller discussion of remedies suitable for different species of noxious insects will be found in various bulletins (Nos. 78, 84, 92, etc.), of this Experiment Station, to which the reader is referred for further information. These bulletins are sent free to all residents of the State who write for them. Figures 63, 64, and 65 show various forms of sprayers and blowers for combating insects in the field and garden.

HOW TO COLLECT AND PRESERVE INSECTS.

The apparatus needed for a young student of insects in field work is neither elaborate nor costly. The things necessary to take with one for a collecting excursion are as follows: A net or bag, which may be of mosquito netting sewed to a wire hoop, about twelve inches in diameter, attached to an old broom handle or stick. If the net is to be used a good deal it will be best to sew the top to a border of muslin two or three inches wide and attach the muslin to the wire. An old umbrella free from holes is an excellent thing for collecting weevils and such other tree-infesting insects as drop to the ground when disturbed. This will be all the better if the inside is lined with white muslin and the handle is hinged in the middle. A similar but stouter and shallower bag, with a handle not over three feet, is called a "beating net," and is much used to scare up and catch beetles and large insects which infest trees and shrubs. Still another and shallower net made of brass wire is used to collect aquatic insects. A twelve-ounce, wide-mouthed bottle containing a piece of cyanide of potassium the size of a hazel-nut covered with about one inch of wetted plaster Paris is necessary to kill insects, and this will usually suffice to hold all the captures of one day until one returns home. But some insects die hard in the cyanide bottle, and if they are put into a bottle containing butterflies or moths, their struggles are likely to cause the loss of the wing scales of the former. Therefore it will be well to carry a tight box small enough to go into the pocket or knapsack and some pins. This box may be lined on the bottom with thick pasteboard, and upon this the more delicate insects should be pinned as soon as dead. For very small specimens many collectors use pill boxes. Most insects should be pinned through the middle division of the body—the chest or thorax. Beetles, however, are usually pinned through the right wing cover and bugs through the triangular shield (*scutellum*) on the chest or thorax. Ordinary pins will do, but most entomologists use specially made pins. These are longer and more slender than ordinary pins. There are several

makes on the market, but those made by Klager, of Berlin, are most esteemed. They do not cost much and are sold by all dealers in scientific instruments. There are five sizes—No. 1 being the smallest, and No. 5 the largest. Usually Nos. 3 and 4 will give best satisfaction. Very small insects are mounted on triangular bits of cardboard and the pin put through the base of the triangle. Gum tragacanth is much used for attaching the insects. Ox-gall is often used for this purpose and for attaching legs and limbs which have been accidentally broken off. Before mounting in cabinet all insects should be soaked for a few days in a preservative liquid—fifty per cent. alcohol saturated with white arsenic is the best preservative. Common whisky may be substituted for the alcohol. Large caterpillars must be soaked for at least two weeks. The nests, galls and cocoons of insects should be soaked for ten minutes in the preservative liquid. After removing from the liquid, let them dry thoroughly, which will render them hard and brittle. Then place in a light box lined with moist blotting paper and let them lie until they become soft and pliable. Have ready a "setting-board." This may be a piece of one and a half-inch pine board with a rabbet or groove one inch deep and half-inch wide through the center—the long way. The face of the board should slant downwards towards the groove one-fourth inch or so. Have ready at hand a supply of pins—ordinary pins will do—and a lot of slender, triangular pieces of cardboard one inch long. Take a pliable insect from the damp box, spread out the wings and legs carefully and place it in the groove supported by the wings. Arrange the wings at their fullest extension and place over them one or more of the cardboard triangles and pin it tight enough to hold the wings in the assigned position. Let stand thus until the insect is dry, then remove and mount in cabinet. It should be remembered, however, that beetles are usually mounted with the wings closed, and for these the setting-board is not necessary.

As for the cabinet, instrument dealers sell many styles at almost any price. A common way is to have shallow drawers made in a frame like those used for holding spools of thread in dry goods stores. Each drawer is closed air-tight with a pane of glass sliding in a groove from the back. The bottom of the drawer is covered with cork or layers of pasteboard one-fourth inch thick and this again with white paper. The insect is pierced with the pin, and below it is a small label containing name, place and date of capture. Sometimes the label contains only a number referring to the collector's private catalogue, which gives all necessary information.

In spite of the arsenical preservative fluid, the cabinet will in time become infested with pests which will soon ruin the collection if left undisturbed. It will be well then every six or eight weeks to open the box and pour into each one, one-fourth teaspoonful of carbon bisulphide. Close tightly as possible and put away until the next application is needed. Keep the carbon bisulphide away from the light and fire, as it is very explosive. It is not poisonous unless

breathed for a long time. Caterpillars and grubs may be mounted the same as winged insects, but these are often preserved permanently in the arsenical solution referred to. Each larva should have a small homeopathic pill vial to itself. The label for this should be written in pencil and placed within the bottle. Another label may be gummed to the outside. A good and complete exhibit of any insect requires the three stages—larva, pupa and imago, or at least the larva and imago or winged stages to be shown. Also both sexes. Usually for the smaller kinds of insects both sexes may be mounted on the same pin, but butterflies and large insects are always mounted separately and the sexes indicated by the marks ♂ (Mercury) for the male and ♀ (Venus) for the female. Occasionally it will happen that only one stage of the insect can be found. In this case one should collect several specimens of that stage and put some of these alive into small bottles or boxes. These should be carefully handled, the food plant upon which it was found noted. When home is reached place some of the food plant in a large wide-mouthed jar or tumbler which has a few inches of soil in bottom. Place the larva or imago in this, and cover the mouth of the jar with gauze. Keep a plentiful supply of the food plant if you have a larva and watch it until it completes its metamorphosis. Several specimens should be secured, so that some may be removed for mounting to show intermediate stages of growth.

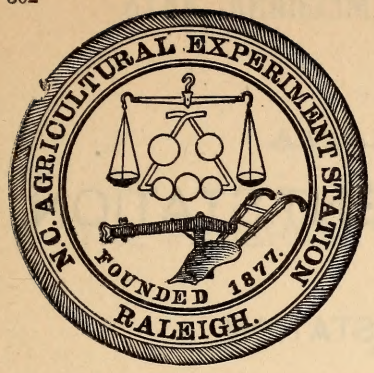
A careful record should be kept giving date and place of capture, food plants and any other information. This information should be included in owner's private catalogue.

BOOKS FOR STUDENTS OF ENTOMOLOGY.

Introduction to Entomology, by J. H. Comstock.
Guide to Study of Insects, by A. S. Packard.
Guide to Teaching Entomology. Hyatt and Arms.
Classification of Coleoptera of North America. Leconte & Horn.
Classification of Hymenoptera of North America. E. T. Cresson.
Classification of Lepidoptera of North America. J. G. Morris.
Classification of Lepidoptera of North America. J. B. Smith.
Butterflies, by S. H. Scudder.
Butterflies of Eastern United States. by G. H. French.
Diptera of North America. Osten Sacken.
Orthoptera of North America. S. H. Scudder.
Neuroptera of North America. Hermann Hagen.
Myriapoda of North America, by Horatio C. Wood.
Myriapoda of North America. by L. M. Underwood.
Spiders of the United States, by N. M. Hentz.

The following are valuable economic works:
Insects Injurious to Fruits, by Wm. Saunders.
Insects Injurious to Vegetation, by T. W. Harris.
Reports of the U. S. Agricultural Department, Washington.
Reports of the State Entomologist of New York.
Reports of the State Entomologist of Illinois.
Reports of the State Entomologist of Missouri.
Bulletins of State Agricultural Experiment Stations.

The above books can be ordered through any bookseller, or of B. Westermann & Co., or E. Steiger & Co., of New York. The reports are not usually sold, but can be had gratis on application to the secretaries of the different States and directors of Experiment Stations.



August 2, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 101.

THE PROGRESS OF THE DAIRY INDUSTRY IN NORTH CAROLINA.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

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RALEIGH, N. C.

THE PROGRESS OF THE DAIRY INDUSTRY IN NORTH CAROLINA.

By H. B. BATTLE, Director.

North Carolina can hardly be considered a dairy State in comparison with others that natural resources and conditions have fostered and encouraged the industry for many years. As long as cotton and tobacco were raised at a large profit, it was not surprising that our planters grew these money crops to the exclusion even of raising their home supplies. With cotton at ten and twelve and fifteen cents per pound, and tobacco at thirty and fifty and seventy cents and more per pound, the inducements to change this system were not numerous. The cultivation of such money crops became thoroughly understood, which became an additional reason for their being continued. Upon the depressing effects, however, of low prices, coupled with bad crop years, a change became essential. Often the total returns of a year's crop were insufficient to repay the labor and the fertilizer bills, and nothing resulted from the year's work save debt and sad experience. The home supplies for the coming year, expected to be purchased with the profits from the usual money crops, were bought at high commission charges, and the result became still more disheartening. A change was necessary, and a change was made. Home supplies have been and are being produced as never before, and the acreage in money crops is materially reduced.

With the diversification of crops, improved stock was introduced, greatly to the advantage of their owners. This was materially augmented by the passage of stock laws, whereby owners were forbidden to allow their animals to run at large. Locally known as "no-fence" laws, they proved of great value in preventing much waste in unnecessary fencing around each field, and in causing owners of stock to feed them far more rationally than ever before, the yields of cows were more closely watched, and the improvement of breed was the almost necessary consequence.

The dairy industry means a very great deal for the State in the improvement of lands, in producing a safe money crop that does not exhaust, in the saving of fertilizer bills, and the necessary use of higher bred stock, whose increase is also of value. Recognizing this, the Experiment Station has endeavored for many years to give encouragement to this industry and to urge our planters to adopt it. No less than eleven separate bulletins have been issued in editions of many thousands each, all bearing upon the care and feeding of stock. Our State may not be blessed with large areas of soils pecu-

TABLE I.—THE PROGRESS OF THE DAIRY INDUSTRY IN NORTH CAROLINA FROM 1879 TO 1889, COMPARED WITH OTHER STATES.

	STATES.	Number of Milch Cows.		Number of Improved Acres in Farms.		Number of Improved Acres to One Cow.		Milk Product, Gallons.	Butter Made, Pounds.		Cheese Made, Pounds.		Each Cow Produced			
													Milk Product, Gallons.	Butter Made, Pounds.		
		1880.	1890.	1880.	1890.	1880.	1890.	1889.	1879.	1889.	1879.	1889.	1889.	1879.	1889.	
1	North Carolina	232,133	223,416	6,481,191	7,828,569	28	35	55,250,665	7,213,507	13,129,374	57,380	60,760	247	31	58	1
2	Alabama	271,443	292,088	6,375,706	7,698,343	23	26	55,508,687	7,997,719	14,548,435	14,091	6,131	190	29	49	2
3	Arkansas	249,407	330,165	3,595,603	5,475,043	14	17	54,325,673	7,790,013	15,724,144	26,301	21,328	164	31	47	3
4	Florida	42,174	113,338	947,640	1,145,693	22	10	5,056,790	353,156	867,195	2,406	1,731	44	8	7	4
5	Georgia	315,073	287,717	8,204,720	9,582,866	26	33	52,234,508	7,424,485	14,483,323	19,151	12,833	181	23	50	5
6	Kansas	418,333	741,786	10,739,566	22,303,301	25	30	201,608,099	21,683,244	50,434,952	1,275,371	2,733,346	272	52	79	6
7	Kentucky	301,882	364,516	10,731,683	11,818,882	35	32	118,497,289	18,261,004	29,038,406	58,468	64,822	325	60	79	7
8	Louisiana	146,454	167,223	2,739,972	3,774,668	18	22	12,881,927	916,018	2,089,774	7,618	3,939	77	6	12	8
9	Maryland	122,907	142,198	3,342,700	3,412,908	27	24	46,601,218	7,676,396	10,846,879	17,416	23,573	327	62	75	9
10	Michigan	384,578	497,611	8,296,862	9,865,350	22	19	224,537,488	38,831,740	52,343,212	3,732,278	5,370,460	453	101	105	10
11	Mississippi	268,178	310,159	5,216,937	6,849,390	19	22	50,803,371	7,454,657	12,988,637	4,239	4,898	163	28	42	11
12	New Jersey	152,078	161,576	2,096,297	1,999,117	14	12	64,003,953	9,529,435	8,866,749	102,918	587,343	396	62	54	12
13	New York	1,437,855	1,440,230	17,717,862	16,389,380	12	11	663,917,240	116,119,848	112,727,515	117,085,442	124,086,524	461	81	78	13
14	Ohio	767,043	794,833	18,081,091	18,338,824	23	23	326,925,396	67,869,604	81,522,792	19,978,436	22,254,054	411	88	102	14
15	Pennsylvania	854,156	927,254	13,423,007	13,210,597	15	14	368,906,480	79,789,032	96,199,428	7,096,491	5,457,897	397	93	103	15
16	South Carolina	139,881	107,184	4,132,050	5,255,237	29	49	23,833,631	3,196,851	5,737,557	16,018	2,476	222	22	53	16
17	Tennessee	303,900	345,311	8,496,556	9,362,555	28	27	107,657,116	17,889,969	28,380,377	107,740	101,219	311	59	82	17
18	Texas	606,176	1,003,439	12,650,314	20,746,215	20	20	118,475,320	13,899,320	32,145,249	58,466	145,370	118	23	32	18
19	Virginia	243,061	273,634	8,510,113	9,125,545	35	33	78,143,459	11,500,023	18,761,856	111,535	218,187	248	47	69	19
20	Wisconsin	478,374	792,620	9,162,528	9,793,931	19	12	303,701,134	33,739,055	60,355,499	19,088,405	54,614,861	383	71	76	20
	The United States	12,443,120	16,511,950	284,771,042	357,616,755	23	27	5,209,125,567	793,721,450	1,205,508,384	199,022,984	258,761,883	315	64	73	

liarly adapted to the easy growth of grasses, as is the case with others, yet with the advent of the silo neither soil nor climate can be considered objections to the progress of the dairy industry in our midst. For this reason silos and ensilage have received especial attention from the Station.

As a result of the several causes enumerated above, the dairy industry has progressed in North Carolina far more than is generally supposed. In order to show this the accompanying table (Table I) has been calculated, which gives the rank of North Carolina as compared with those that are usually recognized as dairy States, and also with other Southern States. The number of milch cows for each State is given, also the number of improved acres in farms, the number of improved acres to one cow, the milk product, the butter product, and the cheese product, also the average milk and butter products for one cow. These figures are given for 1880 and 1890 as well, being the returns of the tenth and eleventh censuses and calculations made therefrom.

The number of milch cows on June 1st of 1880 in North Carolina was 232,133. On the same date in 1890, the number was 223,416, a decrease of 8,717, or 3.75 per cent. This decrease is remarkable, in that the whole United States shows an increase of 32 80 per cent. or nearly a third more in 1890 than in 1880. Only Georgia and South Carolina show a similar decrease as North Carolina. The cause of this is not difficult to discover—in the enaction of the no-fence laws, and the consequent discarding of the poorer grades of cows. That the grade of cows kept are greatly improved, is shown below in the improvement of their product.

The number of improved acres on farms in North Carolina in 1880 was 6,481,191. In 1890 the number was 7,828,569, an increase of 20.79 per cent. In the whole United States the increase was 25.58 per cent. Every Southern State shows an increase of acreage, and of twenty States quoted, only New Jersey, New York and Pennsylvania show decreased acreages. The increase in Kansas is more than 100 per cent., and the total improved acres on farms in Kansas exceed that of Texas by $1\frac{1}{2}$ million acres.

The number of improved acres to each milch cow in North Carolina in 1880 was 28. In 1890 it had increased to 35. For New York in 1890 it was 11; for New Jersey it was 12; Pennsylvania, 14. Florida leads all the United States in having only 10. In South Carolina there are 49 acres to each cow, Georgia has 33, Alabama has 26, Virginia has 33, Mississippi has 22. The whole United States has 27 acres to each cow.

The total amount of milk produced in 1879 is not given in the 10th census. The quantity only *sold from the farms* is returned; to state these figures would be misleading, and hence they are omitted. The total milk product for the year 1889 (11th census) as given in the table refers to the total amount produced on the farms, whether sold or not, and hence can be used for further calculations and com-

parisons. The total milk product in North Carolina in 1889 was 55,250,665 gallons, which is only slightly more than 1 per cent. of the total amount produced in the United States. New York produced 663,917,240 gallons, which is about 13 per cent. of the whole United States. Ohio produced about 6 per cent., South Carolina less than $\frac{1}{2}$ of 1 per cent. Each cow in North Carolina for the year 1889 produced 247 gallons of milk, while the average for the whole of the United States was 315. Each one in New York produced 461 gallons, each in Ohio produced 411, each in Virginia produced 248, and each in Texas 118 gallons. The milk yield is considered a better basis of estimating value than either butter and cheese, as the two last are included in the former.

The total amount of butter made, both for 1879 and 1889 (ending Dec. 31), given in the table, is the sum of the amount of butter made on the farms and that made in factories. The figures show, therefore, an accurate statement of the butter yield for both periods, and can be accurately compared. As given in both censuses the returns are made separately, which are here brought together for strict accuracy. In the case of New York and other States having many butter factories, both of a co-operative nature and otherwise, to omit the butter produced in these factories would cause a very serious discrepancy. In 1879 North Carolina produced a total of 7,213,507 pounds, or about 1 per cent. of the whole United States which made a total of 793,721,450 pounds. In 1889, North Carolina's yield has increased to 13,129,374 pounds, or an increase of 82.01 per cent. The increase in the United States has been 51.87 per cent. North Carolina has accordingly gained 30.14 per cent. *more* than the gain in the whole United States. North Carolina in 1889 made 1.09 per cent. of the total amount produced in the United States, which is a gain over 1879 by 0.18 per cent. New York leads in 1889 (as was the case in 1879) with a production of 112,727,515 pounds, which is 9.36 per cent. of the whole production of the United States. Pennsylvania comes next in producing 7.98 per cent of the whole. Wisconsin produced 5.00 per cent of the whole, Michigan 4.34, Kansas 4.18. Virginia produced 18,761,856 pounds, which is 1.55 per cent. of the whole; South Carolina 5,737.557 pounds, being 0.47 per cent. of the whole; Texas 32,145,249 pounds, or 2.66 per cent. of the whole.

The average butter yield for each cow in the United States in 1879 was 64 pounds. Each cow in North Carolina during that year produced 31 pounds, which is 33 pounds less than the average. New York had 81 pounds, or 17 pounds more than the average. Michigan led the list with 101 pounds, followed by Pennsylvania with 93 pounds. Virginia had 47 pounds, South Carolina only 22, and Florida only 8.

Comparing the butter yields of 1889 with the above, the average individual cow in North Carolina shows the remarkable increase to 58 pounds, nearly doubling her production. While the average cow in 1879 in the whole United States was 100 per cent. better than the

average in North Carolina, in 1889 she was only 26 per cent. better. While the average yield in the United States has in ten years increased only 14.06 per cent., the average yield in North Carolina has increased 87.09 per cent. The average yield per cow in the United States in 1889 was 73 pounds, in North Carolina 58 pounds, in New York 78 pounds, in Michigan 105 pounds, in Kansas 79 pounds, in South Carolina 53 pounds, in Virginia 69 pounds, in Georgia 50 pounds, in Alabama 49 pounds.

The cheese product for the whole United States in 1879, made both on farms and in factories, was 199,022,984. Of this tremendous amount North Carolina made only 57,380 pounds. New York led with 117,085,442. With the exception of Texas and Kentucky, which made only a few pounds more, North Carolina was exceeded in the South only by Virginia and Tennessee. The total cheese made in the United States in 1889 was 258,761,883 pounds, in North Carolina 60,760 pounds. This corresponds to an increase of about 23 per cent. for the United States, and about 6 per cent. for North Carolina. Of the Southern States, the following show productions more than North Carolina, viz.: Tennessee, Texas and Virginia; the following less than North Carolina, viz.: Alabama, Florida, Georgia, Louisiana, Maryland, Mississippi and South Carolina.

What is shown by this array of figures?

1st. That North Carolina has increased her farming capacity 20 per cent. during the ten years preceding 1890.

2d. That North Carolina has discarded thousands of comparatively worthless milch cows and other stock.

3d. That North Carolina has introduced better breeds of dairy and other stock, and has made other improvements dependent upon this fact.

4th. That North Carolina has increased the number of her improved milch cows in proportion to the number of her improved acres more than any other State, with the exception of Florida.

5th. That the total yield of milk, butter and cheese in North Carolina shows very great increase as the result of improved stock.

6th. That the average yield per cow in North Carolina has increased during the ten years previous to 1890 far greater than has been the case in most of the other States, and the actual yield is better than most of the Southern States.

7th. That the number of butter factories in North Carolina are increasing, and it is likely this result will prove as advantageous here as has been the case with the older dairy States.

These encouraging results are due:

1st. To the changing conditions in the agriculture of the State, which demand that home supplies be first made; and next, that money crops be undertaken as far as they can economically be produced.

2d. To the adoption of the "no-fence" laws in almost every one of the middle and eastern counties.

3d. To the encouragement and assistance afforded by the Station and other organizations, agricultural journals, and enterprising individuals.

4th. To the awakening of the people of the State to the benefits derived from the discriminating care of improved stock, and other advantages following in its train.

Should our people be content with what has been done? There is need for greater improvement. Instead of having but little over one per cent. of the milch cows of the United States within our borders, and producing about one per cent. of the milk of the United States, North Carolina ought to have at least five per cent., both of the number of cows and production of milk by the year 1900. And with this increase the State would show corresponding improvements in all agricultural industries. And there is no reason why this should not be.



August 3, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 102.

ENCOURAGEMENT TO THE DAIRY INTERESTS OF NORTH CAROLINA,

THROUGH THE MEDIUM OF THE STATE FAIRS.

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J. H. GILMER ..... Greensboro.
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STATION COUNCIL.

A. Q. HOLLADAY, *Pres. A. and M. College.*
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OFFICERS OF THE EXPERIMENT STATION.

H. B. BATTLE, PH. D ..... Director and State Chemist.
F. E. EMERY, M. S ..... Agriculturist.
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W. F. MASSEY, C. E ..... Horticulturist.
C. F. VON HERRMANN (U. S. Weather Bureau) ..... Meteorologist.
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W. M. ALLEN ..... Assistant Chemist.
C. B. WILLIAMS, B. S ..... Assistant Chemist.
ALEXANDER RHODES ..... Assistant Horticulturist.
ROSCOE NUNN (U. S. Weather Bureau) ..... Assistant Meteorologist.
A. F. BOWEN ..... Secretary.

RALEIGH, N. C.

ENCOURAGEMENT TO THE DAIRY INTERESTS OF NORTH CAROLINA,

THROUGH THE MEDIUM OF THE STATE FAIRS.

By F. E. EMERY, Agriculturist.

It has seemed to us that the State Fair presents a good opportunity to study and encourage the dairy interest of the State. It is true North Carolina is not at present a dairy State. It is equally true she may and can be more of a dairy State than she is. With our interests nearly all centered in agricultural pursuits, it is a shame that dairy products, cattle foods and pork should be brought from without our borders.

Especially is this common practice most inadvisable when we consider the low state of fertility of farming lands generally, and that this is chiefly due to the neglect of live-stock interests and cropping the soil without regard for anything but the present crop.

Extensive cropping must give way to less extensive farming with stock husbandry and intensive methods. By this means, while it is not likely any very remarkable results will be achieved, enough has been done on farms of our acquaintance to show that the improvement by this course is sure and steady, and that a policy of this kind steadily adhered to will secure good crops and prosperity for those who practice it.

There are many who share this belief. Some believe it, or assent to it, but go on in the old way; others stand halting between two opinions and make no progress, while a few start out and blaze the way toward better things. It is to these pioneers that we are all indebted for the light which leads us on, and which promises so much for the future.

If progress is to be made with live stock it must be with one of two kinds of stock, whatever breed is used—the common neglected stock of the country, or that which some one else has improved or kept good. Two ways are open for improvement, *i. e.*, to feed well and to breed well. Some men can buy good stock to start with, while others less favorably situated must start with the best their means will afford, usually native or grade females, and feed them well. Then, by selecting sires better bred than their own stock, great improvements can be made. Having thus started, the way for further gains, to men of large or small means alike, lies in testing what they have with the best comparative means at hand, and to discard the progeny from *all but the best.*

In testing cows we hope to show many of our people one of the best, as it is the most advanced of, methods of testing the comparative, and also the intrinsic value, of cows.

The Babcock Test has become so well known as hardly to need explanation. It is a simple machine by which anyone who can learn to measure milk in a glass tube, who can weigh accurately, and who knows the multiplication table, can easily test milk and determine the amount of fat it contains, and from the fat calculate the amount of butter it will make. This determination of fat also indicates the value of the milk for food or cheese making.

The method of operating is to weigh the milk as soon as drawn from the cow and bring it to a uniform condition by pouring back and forth a few times gently from one vessel to another; measure out a given amount, and put with it an equal volume of commercial sulphuric acid. Then after whirling it in the machine and filling up with hot water it is easy to read the per cent. of fat in the neck of the bottle. Multiply the weight of milk given by the cow at each milking by the number denoting the per cent. of fat and divide by one hundred for the weight of butter fat. Divide the number denoting the butter fat by .85, and the quotient will be the amount of butter which the milk tested should yield. Thus it is but a simple matter, if care is taken, to make the tests with great accuracy.

I. TESTING DAIRY COWS AT THE STATE FAIR OF 1894.

The following is extracted from the premium list* of the State Fair of 1894, October 23—26, and outlines a plan by which the Station offers its coöperation in encouraging the dairy interest of North Carolina.

PREMIUMS FOR BEST DAIRY COWS.

(WITH THE COÖPERATION OF THE N. C. AGRICULTURAL EXPERIMENT STATION.)

OPEN TO ALL BREEDS OWNED IN NORTH CAROLINA.

$40 TO FIRST. $25 TO SECOND. $10 TO THIRD.

It is well known that cows capable of the largest yields of milk, butter and cheese are so highly organized that any undue or unusual movements excite them, diminish their yields of milk and reduce the quality of what they do yield. Hence, the quiet of their usual home surroundings is the best place to make these tests, which shall be made known and the prizes awarded when the cows are placed on exhibition at the Fair. The tests shall be conducted at some time during the month of September by some member of the staff of the North Carolina Experiment Station commissioned to make them.

CONDITIONS OF THE TESTS.

The cows tested must be entered on the regular books of the State Agricultural Society as members of herds competing for herd prizes, or for best cows in their respective classes at the State Fair, and they must be there exhibited or no prize will be awarded even if otherwise deserved.

The prizes will be awarded to the cows which score the highest number of points and which appear on the Fair Grounds in the respective exhibits of their owners, according to the order of the scores earned by the cows.

The highest number of points earned secures the first prize of $40.

The second highest number of points earned secures the second prize of $25.

The third highest number of points earned secures the third prize of $10.

In order to have this test conducted, an owner of cows should enter his herd or individual cows with the Secretary of the Fair for the regular herd or individual prizes, then request a test and name a date in September on which he would like to have the test made. If other dates do not interfere, that will be the date for the test if the Station representative can reach the place in season, otherwise another date will be arranged convenient to both parties. When the date is agreed upon, a deposit of $10 by each person so entering his cows must be made with the Director of the Experiment Station, as a forfeit to partly defray the expenses of the test if the cow is not regularly exhibited. This money is to be returned by the Director whenever satisfactory evidence is given that the tested cow has been placed on exhibition at the Fair.

RULES FOR CONDUCTING THE TEST.

The owner of a cow to be tested shall file a certified statement with the Station representative before the test begins; stating—

*The complete premium list of the State Fair for 1894 can be secured without charge by application to the Secretary, H. W. Ayer, Raleigh, N. C.

1st. The breed; number, if registered, and age of cow in years.

2d. The number of calves she has produced; date of last calving; date of last bull service and when expected to come in milk again; or if not bred, so state.

3d. The separate kinds and amounts of food eaten by the cow in the last ten days before the date of test, and the value of each per ton in dollars. If quality and quantity of food was changed in that time, state how much, and why.

4th. The Station representative will carefully weigh and record the food of each cow tested for the 24 hours of the test, beginning with the evening previous to the day of the test, and he will also inspect the pail and weigh the milk for the last milking before the test begins.

5th. The Station representative shall not interfere with the usual hours of feeding and milking cows except to see that 24 full hours, and no more, are allowed for secretion of milk, and to assure himself of the weight of all the food given the cow under test. He should weigh or measure the water drank, if convenient, without disturbing the cow undergoing the test.

6th. He will weigh and inspect the milk pail before each milking on the day of the test, and weigh and take so much of the milk as will insure an ample amount for specific gravity and fat determinations.

7th. He will proceed with the tests without delay, and may present the owner of each tested cow a copy of what he finds, upon the owner's faithful promise not to divulge the result to anyone until after the coming State Fair; but the representative shall impart such information to no other person except the Director of the Experiment Station, who will keep the tests secret until after the public announcement has been made at the State Fair.

8th. The Quevenne Lactometer for specific gravity and Babcock Tester for the per cent. of fat shall be used to determine the valuable constituents of the milk.

9th. Each cow will be credited with as many points as her product periods of lactation and gestation can reach on the following scale:

For every 20 days lactation	1 point.
For every ten days gestation	1 point.
For every two onces of solids, not fat, yielded in 24 hours	1 point.
For every ounce of butter fat yielded in 24 hours	2½ points.

If Breeders' Associations, or individual owners of pure bred cattle wish to offer similar prizes for their respective breeds, they will be accepted and the tests made under the above terms for all such entries of cows owned in North Carolina as may be exhibited at the State Fair.

Records of Tests.

There will be three forms that will be used in connection with the tests: 1st. Breeder's Form, No. 1, giving the application of the owner of the cow for admission into the contest, with certain information in regard to his stock. 2d. Breeder's Form, No. 2, showing food consumed per day for ten days previous to the test. 3d. Tester's Form, giving the record of tests and the result of marks as per conditions already set forth.

APPLICATION FOR COWS TO BE TESTED FOR PREMIUM AT STATE FAIR, 1894

I HEREBY CERTIFY THAT THE INFORMATION GIVEN BELOW IS CORRECT IN ALL RESPECTS.

BREEDER'S FORM, No. 1. ----------, OWNER.

NAME OF COW AND REGISTERED NUMBER.	Breed of Cow.	Age of Cow (Years).	Date of Last Calving.	Number of Calves Produced.	Has Cow been Bred Since Last Calving?	Date of Last Service.	OWNER AND POST-OFFICE ADDRESS, WITH NAME OF FARM.

FOOD CONSUMED PER DAY BY COWS FOR TEST DURING 10 DAYS PREVIOUS TO TEST. (*If any change on or before date of test, indicate it under Remarks.*)

I HEREBY CERTIFY THAT THE INFORMATION GIVEN BELOW IS CORRECT IN ALL RESPECTS.

BREEDER'S FORM, No. 2. ----------, OWNER.

KINDS OF FOOD EATEN.	Pounds Fed of Each Article.	Pounds Refused by Cow.	Pounds Food Consumed.	REMARKS ON CONDITION OF FOOD OR COW.

RESULT OF TESTS.

THE FOLLOWING RECORD OF TESTS OF THE COWS NAMED WAS MADE BY ME AT ---------- ON ----------, 189--, AND IS HEREBY CERTIFIED TO BE CORRECT IN ALL RESPECTS.

TESTER'S FORM. ----------, TESTER.

NAME OF COW TESTED		Yield of Milk in 12 Hours.	Specific Gravity (Quevenne).	Per Cent. of Fat (Babcock Test).	Ounces of Solids not Fat.	Ounces of Fat.	Points Allowed on Lactation.	Points Allowed on Gestation.	Points Allowed on Total Solids.	Points Allowed on Fat.	Total Points Allowed.
	a. m.										
	p. m.										
	a. m.										
	p. m.										

II. TESTING DAIRY COWS AT THE STATE FAIR OF 1893.

In order to create interest in the need of accurate tests of dairy stock in determining their value, the work described below was done. The following circular was distributed to the owners of the cows on exhibition at the State Fair grounds in 1893:

TEST OF COWS AT THE FAIR.

The value of every cow to her owner is measured by the income she is able to bring in calves, milk, butter, or cheese. In all cases where there is only a limited market for milk, the most profit may be realized from the manufacture and sale of butter, including the by-products, skim milk and buttermilk. Hence the amount of butter fat and quantity of butter which may be made from a cow has been shown to be a fair test of the cow's capacity to return profit or not.

Cows of equal merit, so far as any external differences may and have been shown to exist, differ very widely in the return they make for a given amount of food and care.

It is proposed to give exhibitors a free test for one day of the Fair of every cow presented in competition for the prizes offered by the Society. This will show the breeder something of the real relative merit of his stock independent of external points, and will also serve to show the simplicity of the accurate tests by which each may continue at home to discriminate between members of his herd; to weed out the least profitable, and to raise calves only from those cows which show themselves worthy to breed from.

The data the young men, students at the North Carolina College of Agriculture and Mechanic Arts (under the direction of the Agriculturist of the Experiment Station) will need in order to make these tests of the greatest comparative value, is enumerated below:

(1) Name and address of owner.
(2) Breed of cow.
(3) Name and registered number of cow if eligible to registry.
(4) Kinds and amount of food used per day.
(5) Weight of milk given at each milking.

In order to make the test complete, the man in charge of the test must see the cow milked out the night before the test begins, and be present at each milking to weigh the pail before the cow is milked and the milk afterwards, when he will take the sample for the test.

Scales and sample pails will be provided by the Experiment Station and the data collected will be turned over to the Agriculturist of the Station for discrimination. Each owner of a cow tested will be furnished with a copy of the report of the test, either in manuscript or printed, at the earliest opportunity.

For these tests two members of the senior class of the A. and M. College were put in charge of the work of taking the samples and making the tests. No notice was given of a desire to test cows previous to their appearance on the Fair grounds; therefore no preparation could have been made for it, and in fact the cows had been fed on the regular home rations, as given below.

Ten cows were secured for trial. Messrs. Patterson and Walton of the A. and M. College were on hand, and saw the cows milked on the evening of the second day of the Fair, and on the third day took samples morning and evening, and made the tests in connection

with the Experiment Station Exhibit, where visitors could see the whole operation.

The cows were not milked with the usual regularity, it being late when the attendants began in the morning and early for milking in the evening, but the last milking was very nearly 24 hours from the milking on the preceding day, so it was very nearly a 24 hours test for each cow. The yields and percentages of fat are subject to some fluctuation by variations from the ordinary treatment, such as moving to the Fair, and constant passing of strangers; hence we should not consider these results as equal to the every-day yields at home of the cows submitted to trial.

The cows entering into this test were one Ayrshire and one Holstein-Friesian, which Mr. J. B. Burwell, Raleigh, N. C., exhibited in their respective classes.

Two Guernseys from Dr. R. H. Lewis's Cloverdale Farm, entered in the Guernsey list by Messrs. Bradshaw & Tyson, who also entered a cross-bred cow, three-fourths Jersey and one-fourth Guernsey, and one native belonging to Mr. Tyson.

There were four registered American Jersey Cattle Club cows from the herds of Maj. R. S. Tucker, Raleigh, N. C., and Col. J. S. Carr, Hillsboro, N. C.

The feed of the cows before and at the Fair was as follows:

Ayrshire and Holstein-Friesian.—These were grazed and fed on silage once daily, with a small grain ration, consisting of cotton-seed meal and wheat bran, mixed in the proportions of 2 to 1, and stock beets (mangolds) once a week, making in all, as much as the cows would eat.

Guernseys.—Corn silage *ad libitum* twice daily, with a grain ration of wheat bran and cotton-seed meal in proportions of 1 to 2. Fed at Fair same as at home on silage and grain.

Cross-bred and native cows same as Guernseys.

Jerseys—Major Tucker's cows were fed chops with wheat bran half and half, with crab grass hay all they would eat.

Colonel Carr's cows were fed pulled corn fodder, orchard grass, and other hays, oats, wheat bran and cotton-seed meal. Proportions were not ascertained.

The amount of food for all the cows was rather indefinitely stated. owing to not being accustomed to measure or weigh feed accurately,

The following table shows the data collected:

TABLE II.—RESULT OF DAIRY TEST AT STATE FAIR OF 1893.

TIME. Oct. 19, '93.	Name and address of Owner.	Age of Cow (Years.)	Breed of Cow.	Date of last Calving.	Name and Registered Number of Cow.	Weight of Milk. Pounds.	Per cent. fat in milk.	Pounds fat in Milk.	Equivalent in pounds Butter at 85 per cent. Fat.
Morning	Jno. B. Burwell, Raleigh, N. C.	9	Ayrshire	May, 1893	Carrie Bell (9435)	7.59	4.20	.319	.63
Evening						4.00	5 40	.216	
Morning	Jno. B. Burwell, Raleigh, N. C.	5	Holstein-Friesian.	June, 1893	Princess of Wake (17505)	13.125	3.60	.472	.108
Evening						9.31	4.80	.447	
Morning	R. H. Lewis, Raleigh, N. C.	10	Guernsey	July, 1893	Queen (1654)	3.81	7.00	.267	.623
Evening						3 56	7.40	.263	
Morning	R. H. Lewis, Raleigh, N. C.	5	Guernsey	April, 1893	Edgarda (559)	2.00	4.50	.090	.324
Evening						3.00	6.20	.186	
Morning	R. H. Lewis, Raleigh, N. C.	11	Cross-bred: ¾ Jersey, ¼ Guernsey.	Oct. 7, 1893.	Edith	19.81	3.20	.634	1.238
Evening						11.625	3.60	.418	
Morning	Mr. Tyson, Raleigh, N. C.	9	Native	Sept., 1893	White Head	5 187	*1.40	.0726	.191
Evening						3.00	3.00	.0900	
Morning	R. S. Tucker, Raleigh, N. C.	7⅞	Jersey	July, 1893	Speed of Gaston (43079)	8.00	5.60	.448	.777
Evening						4.30	6.80	.2124	
Morn., 20th	R. S. Tucker, Raleigh, N. C.	7⅞	Jersey	Oct. 16, 1893	Rhoda St. Helen (39077)	8.40	4.20	.3528	.557
Even., 19th						4.30	**2.80	.1204	
Morn., 19th	J. S. Carr, Hillsboro, N. C.	3½	Jersey	March, 1893	Moon Flower (59922)	1.05	6.30	.066	.146
Even., 19th						.90	6.40	.058	
Morning	J. S. Carr, Hillsboro, N. C.	6	Jersey	March, 1893	Romola (47860)	***5.00+	8.40	.42+	1.129+
Evening						6.75	8.00	.54	

** Rhoda St. Helen had a young calf by her side and mental excitement reduced the per cent. of fat. This was the first milking after the calf was removed, and her flow of milk had not become established. Morning of the 19th calf taken away and morning's milk of 20th taken for test.

*** Romola being milked by unfamiliar hands resented and kicked over part of the morning milk, hence the plus sign attached to yields from her. * Morning test from White Head repeated next day with the same results.

When the first tests were made and the milk from White Head gave so low a percentage of fat, it was repeated again next day. The second test coincided with the first, and she might be called a skim-milk cow. Since the Fair, when their attention was called to this, Messrs. Tyson & Bradshaw informed us this cow was "off feed" that day, and hence not in normal condition. Her heifer calves by a Guernsey sire will doubtless show great improvement.

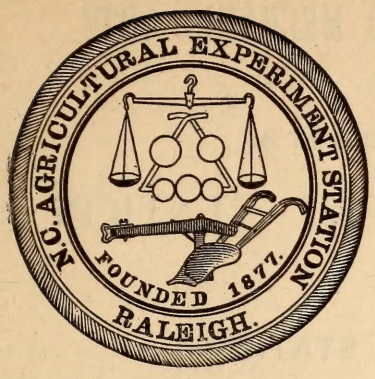
In case of a few of these cows, the yield has fallen so low as to point them out as poor specimens for milkers. Edgarda and Moon Flower are the most striking examples. Unless there is some good reason for this small yield, like having been bred again immediately, or sickness, they would appear to be but poor specimens of their respective breeds.

Edith, the cross-bred cow, fresh in milk, and at height of flow, leads in yield, while Romola, calved in March, and Princess of Wake in June, with over a pound of butter per day each, have a good claim to superiority. Rhoda St. Helen, with a two days' old calf, gave us what we might expect from her milk not having changed to its normal condition at the first trial. It was evidently a sample of colostrum which was tested. Neither the yield nor per cent. of fat were up to the normal for this cow at the time of the test.

RECENT BULLETINS OF THE EXPERIMENT STATION.

Bulletins will be sent to addresses in North Carolina free of charge. To parties outside of the State a small fee of 6 cents each (10 cents each for Nos. 73 and 92) is charged, or 25 cents per year. Only a limited number can be sent to each address, and the Station therefore must request parties to confine their applications to actual needs. Apply to Dr. H. B. Battle, Director, Raleigh, N. C.

No. 70. Weed Pests of the Farm; Japan Clover, plates 11, pp. 28.
No. 71. Co-operative Field Tests during 1889; Hill-side Ditches, Fig 1, pp. 32.
No. 72. Work in Horticulture; Pea-vine Manuring, pp. 16.
No. 73. The Best Agricultural Grasses, plates 74, pp. 100.
No. 74. Tests of Garden Vegetables; The Culture of Figs, plates 2, pp. 20.
No. 75. Fertilizer Analyses; Season of 1891, pp. 16.
No. 76. Plant Diseases and How to Combat Them, plates 13, pp. 20.
No. 77. Value of Pea-vine Manuring for Wheat, plate 1, pp. 8.
No. 78. Some Injurious Insects, plates 37, pp. 32.
No. 79. Facts for Farmers in Plain Language for Farmers' Reading, pp. 24.
No. 80. Silos and Ensilage, pp. 17.
No. 81. Feeding Cotton-seed Hulls and Meal for the Production of Beef, pp. 28.
No. 82. Fertilizer Analyses and the Fertilizer Control for 1891, pp. 20.
No. 83. Growing Celery in the South; Cultivation of Onions; Notes of Horticultural Work During 1891, Figs. 2, pp. 20.
No. 84. Some Enemies of Truck and Garden Crops, Figs. 32, pp. 26.
No. 85. The Late Crop of Irish Potatoes in the South, pp. 10.
No. 86. Tobacco Curing by the Leaf; Cure on Wire and the Stalk Processes, pp. 32.
No. 87. All Publications of the Station, from March, 1877, to September, 1892, pp. 20.
No. 88. Fertilizer Analyses, and The Fertilizer Control During 1892, pp. 24.
No. 89. Co-operative Field Tests During 1891 and 1892, pp. 48.
No. 90. Practical Stock Feeding, pp. 32.
No. 91. Some Experiments in Wheat Culture, pp. 20.
No. 92. The Culture of Orchard and Garden Fruit, Figs. 91, pp. 148.
No. 93. Feeding Experiments, pp. 48.
No. 94. Horticultural Tests and Results with Vegetables, Fruits and Bulb Culture, pp. 20.
No. 95. The Fertilizer Control During 1893, pp. 32.
No. 96. Miscellaneous Agricultural Topics, Figs. 19, pp. 32.
No. 97. Digestion Experiments, Fig. 1, pp. 48.
No. 98. Some Leguminous Crops and their Economic Value, Figs. 9, pp. 40.
No. 99. Thread Worm of Pork (Trichina Spiralis), Figs. 9, pp. 8.
No.100. Our Common Insects, Figs. 65, pp. 36.



August 17, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 103.

MISCELLANEOUS AGRICULTURAL TOPICS

CONTAINED IN

THE PRESS SERVICE BULLETINS OF JANUARY TO JUNE, 1894.

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

BOARD OF TRUSTEES OF THE A. AND M. COLLEGE.

W. S. PRIMROSE, *Chairman*, Raleigh.

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D. A. TOMPKINS.....Charlotte.
H. E. FRIES.....Salem.
N. B. BROUGHTON.....Raleigh.
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W. E. STEVENS.....Clinton.
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J. F. PAYNE.....Alma.
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ROSCOE NUNN (U. S. Weather Bureau).....Assistant Meteorologist.
A. F. BOWEN.....Secretary.

RALEIGH, N. C.

PREFACE.

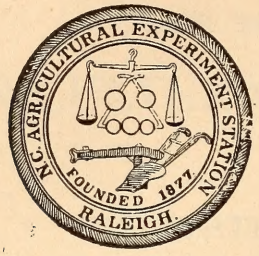
As has been stated previously, the press bulletins of the Station were inaugurated to present a condensed summary of the work of the Station in the columns of the local newspapers and agricultural journals. The plan first put in operation, on May 24, 1890, has continued to meet with favor. The press service plan for distributing these articles by means of plates, first commenced on June 8, 1894, has proven so acceptable that they have been reprinted in the form of regular bulletins. The regular bulletin, No. 96, contained these articles for the seven months previous. The present bulletin contains the instalments that appeared from January to June, 1894, inclusive.

The following is extracted from the preface of bulletin No. 96, and applies with additional force since that bulletin was issued: "Such have been the calls for information contained in these press service bulletins, that it has been determined to reprint, in the following bulletin, the seven monthly instalments published from June to December, 1893, inclusive. Such also have been the repeated endorsements of the plan of sending out this information, that the Station does not fear adverse criticism (if there be any) questioning whether such work legitimately comes under the scope of agricultural research and experimentation. If there should be any critics disposed to doubt the advisability of it, their attention is drawn to the *first* sentence of the well-known Hatch Act":

"That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture," etc.

H. B. Battle, *Director.*

THE EXPERIMENT STATION



At Raleigh, N. C., Presents Matters of Interest to Agriculturists.

Its Publications Are Free to Those in North Carolina Who Really Desire to Read Them.

JANUARY 27, 1894.

No Distribution of Plants, Seeds, &c.

The Experiment Station has no supply of seeds, plants, &c., for general distribution, and correspondents should remember this fact and not write for them. It does not attempt to keep a supply on hand for the reason that it is not in the province of its work to distribute common seeds, and besides there are nurserymen and seedsmen who make it their business to keep these stocks and can fill your orders. Occasionally the Station distributes one or two varieties of new seeds or plants, when they are promising, but unless you see a distinct announcement of this fact, please do not make application to the Station.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the Station to all in the State who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited by them, please do not apply for them. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Formulas for Composts and Home-made Mixtures for Cotton and Corn.

1. Stable manure,	600	lbs.
Kainit,	200	"
Acid phosphate,	800	"
Cotton seed,	400	"
	2,000	lbs.
2. Kainit,	200	lbs.
Acid phosphate,	600	"
Stable manure,	600	"
Cotton seed meal or fish scraps,	600	"
	2,000	lbs.
3. Kainit or ashes,	200	lbs.
Acid phosphate or bone meal,	800	"
Stable manure with yard scrapings and leaves,	1,000	"
	2,00	lbs.
4. Acid phosphate or bone meal,	600	lbs.
Ashes,	200	"
Stable manure,	600	"
Rich earth or yard scrapings,	600	"
		"
	2,000	lbs.

These are given as suggestions. Individual requirements may need somewhat different proportions with a change of ingredients at hand. Composts should be laid down under shelter if possible, and on stiff clay foundation and level so that no leachings may run off. About six weeks before ready to use, put down a layer of stable manure three or four inches thick, then a thinner layer of cotton seed (if this is used) then a layer of acid phosphate, and finally a layer of kainit. Each layer should be thoroughly wet after it is put down. Repeat layers until heap is built up three or four feet. Then cover with a layer of dirt to protect it and prevent leaching from rain. Examine from time to time and wet the heap if there is undue heating. At the time for hauling to the field, the heap should be cut down from top to bottom and mixed thoroughly as possible. When ashes are used it is best not to allow them to come in contact with the stable manure, as there might be some tendency to decompose it.

A dry mixture about equal to the ordinary complete ammoniated fertilizer would be:

Acid phosphate,	1,200	lbs.
Kainit,	200	"
Cotton seed meal,	600	"
		"
	2,000	lbs.

These can be easily mixed at any time before using; a large, tight box or wagon-body is very suitable. Have two men stand on opposite sides and mix with hoes. If materials are dry, they can be easily and thoroughly mixed at a nominal cost. Do not expose to weather before use.—H. B. BATTLE, Director N. C. Experiment Station.

Soy (Soja) Beans Ought to be Planted.

A correspondent writes: "When is the right time to sow (or plant) soy beans? What kind of soil and how should it be prepared for same? How do they compare with black peas as a feed and land improver? By giving this information you will greatly oblige."

Soy beans should not be sown broadcast, but planted in hills or drills 2½ or 3½ feet apart according to richness of soil. If in hills, 15 to 24 inches is far enough apart in the row. They will doubtless grow on any soil that corn will grow on, and may be planted at the same time as corn, which gives a long season from March to July. It is a good plan to plant in the corn rows between the hills or stalks of corn. If corn is grown for silage, the beans can be cut with the corn and will add greatly to its value. The upright growth of soy beans leaves room for cultivation, and this should be accorded to check the growth of weeds.

As food for stock, the soy bean is one of the richest legumes that can be grown. In chemical composition the dry matter of soy-bean-silage and Black peavine hay differ more in fat and other carbohydrates than protein. The roots of soy beans bear numerous tubercles, which aid it by gathering nitrogen from the air the same as those of the peavine or clover roots. There is no spreading by running vines to shade the ground, which is one of the potent factors in soil improvement, hence soy beans must be planted near enough for shade. On poor soil there should be one plant every 2x1 feet and from that up to 2x3½ feet. It is usual to plant 2 to 4 beans in a hill, as it makes the stems finer, and they are hard and woody at best. They are well suited to grow in any part of this state and can be depended on for good crops of seed. To save the seed the stalks should be pulled or cut and stacked up loosely as soon as leaves and pods have changed from green to a golden hue, and when dry threshed out. The pods should not be hand-picked, because there are too many and with only one to three beans in a pod it will not pay. They will beat out very easily when ripe and dry, as he who leaves them too long will learn to his cost, for the pods will open and the peas scatter upon the ground. This is a most desirable plant to raise for stock. It is also a good table bean, but requires a long time in cooking, and most people will have to learn to like its flavor.—F. E. Emery, Agriculturist N. C. Experiment Station.

Lathyrus Sylvestris or Flat Pea.

The so-called Flat pea, Lathyrus Sylvestris, is closely related to the Vetches, but is a perennial. The other species of Lathyrus are commonly called vetchlings and have little agricultural value. All contain a poisonous alkaloid, but the introducer of the Flat pea claims to have improved or bred out the poisonous principle. The most extravagant claims have been made for this plant by its introducer. The improved plant originated in Germany.

In the spring of 1890 a small package of Lathyrus seed was received at this station from the English disseminator, about three-fourths of the package was soon on a trial plot adjoining similar plots of Lucerne, Spotted Medic and various clovers. The soil was a gravelly red clay naturally well drained and was enriched by a heavy dose of a complete commercial fertilizer. At the end of one month only a few very feeble Lathyrus plants were alive, and these were soon smothered by wild grasses and disappeared wholly. During the same time the neighboring plots of Lucerne, etc., grew finely.

The remaining Lathyrus seed was then sown in a box and kept on a shaded porch. At the end of six months about fifteen plants from one to two inches high were alive. In the fall these were transplanted to a row in the pear orchard on the Experiment Farm. The soil was a well enriched loam. All these plants were alive the next spring, but during the whole season grew only a few inches. Weeds and grasses were carefully removed by hand every two or three weeks. The next spring eleven of the plants were removed from the orchard and set in a single row on a rich and mellow terraced hillside, where they have remained since. The plants so far have not flowered, and of course no seed has been formed. The plants grow flat on the ground, too low to be mowed, and as new leaves grow at end of stem the older ones behind rot. From its behavior with us Lathyrus Sylvestris promises no practical value as on account of the low vitality of the seed and the extreme slowness of growth of the plant. On good or average soil it is certain to be overpowered and smothered by Crab and Bermuda grasses and weeds.

If this plant posseses any economic value it will be for the sand-hill region, where wild grasses and weeds are less intrusive. We cannot advise anyone to invest largely in this plant at present. The seed now costs $4.00 per pound and is advertised by most seedsmen.—Gerald McCarthy, N. C. Experiment Station.

Advanced Meteorological Summary for North Carolina, December, 1893.

The N. C. State Weather Service issues the following advanced summary of the weather for December, 1893, as compared with the corresponding month of previous years:

Temperature.—The mean for the month was 44.1 degrees, which is 1.4 above the normal. The highest monthly mean was 51.1 at Wilmington; lowest,

37.2, at Blowing Rock. Highest temperature, 76 on the 1st at Washington, on the 3rd at Tarboro; lowest, 10 on the 5th at Bakersville. The warmest December during the past twenty-two years was in 1889—mean, 52.9; coldest December during past twenty-two years in 1876—mean 34.2.

PRECIPITATION.—Average for the month, 3.15 inches; this is 0.85 inch below the normal. The greatest amount was 5.88 at Washington; least amount, 0.79 at Mocksville. The wettest December in twenty-two years occurred in 1884—average, 6.77; the dryest, in 1889—average, 0.59 inch. There was only one day (the 5th) with snow of any considerable amount; greatest total snowfall reported was 7.00 inches, at Henderson. Unusually heavy sleet occurred on the 5th in the vicinity of Goldsboro and Falkland.

WIND.—Prevailing direction, southwest. The normal direction is northeast. Average hourly velocity, 9.1 miles. Highest velocity, 60 miles per hour at Kitty Hawk on 5th.

MISCELLANEOUS.—Thunderstorms were reported on the 3rd at quite a number of places in the eastern and central part of the State; at three stations on 16th. Sleet or hail on 2d, 3rd, 4th, 5th, 14th. Snow on 4th, 5th, 17th. 18th, 31st. Halos on 15th, 20th, 22d, 24th. Meteors were observed on the 11th, 20th and 28th. On the morning of the 20th an unnsually large, bright one was observed in the east.

Cold Waves.

Cold waves are those sudden changes from high to very low temperature which constitute the most noteworthy feature of winter weather in the United States. They are produced by the flow of masses of cold, dry air from the regions east of the Rocky Mountains in British America, towards the south or southeast. During the long winter nights of the Arctic regions dry, clear air accumulates in deep layers which is cooled by radiation to a temperature many degrees below zero; and then commences to flow towards any place where warm air is ascending, as it does in the low pressure areas or storms which constantly pass from west to east across the United States.

A "low area" is produced by the air, somewhere becoming heated from unknown causes, above the surrounding atmosphere. This excessively heated air ascends and air is drawn in below from all sides to replace it. That drawn in on the south to east side is warm and moist; that drawn from the north to west side is dry and cold. The cold wave follows after the low area as it moves eastward. The severer and prolonged cold waves are associated with extensive areas of high pressure. Their rate of progress averages eight hundred miles in twenty-four hours.

It is of great advantage to many business and agricultural interests to know in advance when the temperature will fall quickly and decidedly, besides affecting the comfort and health of thousands of people.—C. F. VON HERRMANN, Meteorologist, N.C. Experiment Station.

Analyses of Fertilizers.

The North Carolina Experiment Station will issue in a few days complete analyses of samples taken during the spring and fall season of 1893. This will give the standing of the various fertilizers on sale during 1893, together with the comparative value of the unmixed ingredients at the seaboard. Tables of freight rates on the railroads will be given so that charges to nearly all interior towns can easily be seen. This bulletin list will be sent to all names on the station publication list.

During the spring season of 1894, analyses will be promptly made as soon as samples can be taken by the official inspectors. These analyses will be printed every two weeks, but will only be sent to those who specially apply for them. One application only is necessary for the whole series of bi-weekly editions. Those who are interested in these fertilizer analyses are advised to make application on postal card to Dr. H. B. Battle, Director, Raleigh. N. C,

QUESTIONS AND REPLIES.

The Station will be glad to receive questions on agricultural topics from any one in North Carolina who may desire to ask for information. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Note.

In a recent press article, in referring to saltpetre as a fertilizer, the writer had in mind Chili saltpetre, or nitrate soda. There is another saltpetre, the nitrate of potash, which of course contains potash in addition to nitrogen. As was stated, saltpetre is not a complete fertilizer, and other ingredients must be added to it. This is so with either form, but in the case of nitrate of potash only acid phosphate or some form of phosphate is needed to make it a compiete application. The Chili saltpetre (nitrate soda) was meant because it is the only saltpetre that here is used agriculturally.—H. B. BATTLE.

Satsuma Orange Trees.

Will you please furnish me with information about the Satsuma orange trees at your station?—M. W. C., Tallahassee, Fla.

(Answered by W. F. Massey, Horticulturist N. C. Experiment Station.)

The Satsuma orange trees are dead. The cold of last winter finished the last of them. They will stand a cold of 18° to 20°, but lower than this hurts and finally kills them. On our southern coast, I believe they will do well. They will stand our ordinary winter, particularly as they grow older, but a winter like that of 1892-93 will always destroy them.

Keeping Nitrate of Soda.

Please let me know how I can keep over, from one season to another, a lot of nitrate of soda without loss. I have tried keeping it in boxes, but the box, floor and everything near, becomes saturated with air-dissolved nitrate. I am trying this winter to keep it in kerosene oil barrels, and up to this time there is no sign of losing. I cover the top with about three inches of dry packed earth.—R. P. M., Saxon, N. C.

(Answered by H. B. Battle, Director, N. C. Experiment Station.)

The reason that Nitrate of Soda absorbs moisture is the same as that given for Kainit in the newspaper article which you noticed. If therefore the Nitrate of Soda can be put in a box or barrel so that the air can not well get to it, it can not absorb moisture and become wet and lumpy. The plan that you suggest of placing it in oil barrels and covering with dry packed earth is a good one.

The loss resulting from absorption of water and leaking would depend entirely upon conditions of the atmosphere, exposure, and causes similar.

Clover and Grass for Loamy Land—Peanuts—Chufas.

What are the best clover and grasses for light loamy land? Are peanuts or chufas better for turning hogs on in the fall?

(Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.)

You will find orchard grass the hardiest and most vigorous grass you can use for hay. To thicken the stand and improve the hay, Kentucky blue grass is a favorite, while common red clover flowers near the time of both grasses. These make prime hay, and will grow well if treated to an occasional coat of stable manure. You will hardly make grasses profitable without this manuring. Probably you could get much more clean cash out of annual clover grown for seed. It should be sown in August or any time in the fall when there is likely to be moisture enough to give the little plants a fair start, so that early winter frosts will not pull them out of the ground. This clover will ripen in May. You can feed the straw, and the seed should sell for $5 or $6 per bushel.

Our experience with chufas is that there has been too small a yield to compare with peanuts, though we have not turned hogs on them. Some of our farmer friends have had experience with them, and have been beaten by neighbors growing peanuts. They will hereafter grow only peanuts for hogs.

The Cultivation of Onions and Irish Potatoes.

I have plowed in fifty loads of good stable manure on two acres of land which I want to plant in onions. Will it require more manure? Please give best time and method of cultivation; also, whether to plant seed or sets. What is the best way to grow and cultivate Irish potatoes? Is commercial fertilizers as good as stable manure?—R. P. R., Newton, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

It is hard to grow a first-class crop of onions on land that has not been cultivated in vegetables and heavily manured for some years before. You do not say anything about the previous quality of your land, nor what kind of loads of manure you applied, nor the quality of the manure. Manure from highly fed animals and not of too strong a character is a very different article from ordinary yard manure. Fifty ordinary loads of ordinary manure on ordinary farm land will not grow a fine crop of onions—particularly if the land is of a clayey character. You cannot make land too rich for onions. On the land you name we would advise the addition of not less than 700 to 1,000 pounds of a complete commercial fertilizer, such as is made for tobacco growing, in the furrow under the onion rows. If you intend to grow ripe onions you should always sow the seed in February, as you can thus raise better onions than you can from sets. To raise early grown onions it is best to plant sets of the White Pearl onion in October. Seed would do just as well for these if sown in September, but the uncertainty of our fall weather and liability of dry weather at this time renders the germination of the seeds at this time rather uncertain. We therefore advise sets for fall planting. For spring sowing use seeds of the Prize Taker (a large yellow onion), White Globe, Southport, Pearl or Giant Rocco (brown.) The White Globe is the best keeper.

Plant early Irish potatoes in February, with 1,000 pounds of complete fertilizer per acre, well worked in the furrow and cultivate thoroughly. Commercial fertilizer is better than manure for Irish potatoes, as they grow smoother and are less liable to scab. If the land has been in clover or peas the previous year, the crop will be much better.

THE EXPERIMENT STATION

At Raleigh, N. C., Desires to Assist the Farmers of North Carolina

By Sending Its Publications to Those Who Really Desire Them or by Advices as to Agricultural Subjects.

MARCH 29, 1894.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the Station to all in the State who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited by them, please do not apply for them. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Some Late Bulletins of the North Carolina Experiment Station.

The following gives a short description of each of the bulletins issued lately. Each number will be sent free upon application from residents in North Carolina. A small fee (10 cents for 92 and 4 cents for each of the others) is charged those living in other states.

No. 90. Practical Stock Feeding, pages 32. This bulletin gives composition of various feeding stuffs—the nutrients, the nutritive ratios, the digestible portions, tables of feeding standards, the calculation of rations, the full values of fodder and the comparative value of feeds—a valuable bulletin for the practical feeder who desires to understand what he is about.

No. 91. Some Experiments in Wheat Culture; pages 20; cuts 3. Describes the effect of plowing under a crop of ripe cow pea vines for manuring for wheat during a succession of four years on the same ground. The average gain due to this manuring for a series of years per acre was

With no additional fertilizers, 9.68 bu.
With 300 lbs. kainit, 16.46 bu.
With 300 lbs. acid phosphate, 16.81 bu.
With 300 lbs. cotton seed meal, 7.83 bu.
With 175 lbs. acid phos. | 87.5 " cottonseed meal | 37.5 " kainit | 14.67 bu

Seventeen varieties of wheat were also tested, together with the depth of planting. It was found that three inches was the best depth. Best varieties were the following: Winter Green, Tappahannoc, Kivet and Fulcaster.

No. 92. Culture of Orchard and Garden Fruits; pages, 150; 91 cuts illustrate the text. Practical methods for the planting and after treatment of orchards and vineyards; also description of the various insects and fungous pests affecting the growth of trees, vines and small fruits, and methods to destroy them.

No. 93. Feeding Experiments; 46 pages. Includes experiments in fattening stock for beef with cotton seed hulls and meal; feeding with corn silage and soja (soy) bean silage with cotton seed meal; also feeding an exclusive ensilage ration, and a discussion of what is a maintenance ration.

No. 94. Horticultural Tests and Results with Garden Vegetables, Fruits and Bulb Culture; pages 20. Gives tests of cabbages, melons, garden corn, cucumbers, egg plants, lettuce, onions, Irish potatoes, tomatoes, strawberries, raspberries, blackberries, figs, peaches, tube roses, lilies, gladioli, early hyacinths and roses.

No. 95. The Fertilizer Control during 1893; pages 32; includes official analysis of spring and fall samples and a description of ingredients in fertilizers and their analysis. This bulletin describes the materials of which fertilizers are made and their composition; also gives the method for arriving at the valuation of the ingredients by the experiment station, and how to calculate the values per ton reckoned upon the percentages of the three valuable ingredients. Correct freight rates are given to 56 interior points in North Carolina from Wilmington, Norfolk, Charleston and Richmond.

No. 96. Miscellaneous agricultural topics contained in the press service bulletins; pages 32; many practical points of value to the agriculturist are given in plain language. A feature of the bulletin is the collection of the questions and replies upon important farm subjects.

No. 97. Digestion Experiments; pages 48; the results of the detailed work in these pages are described in plain language in a few pages in the beginning, so that a tired man can reach the conclusion at once. For the detailed scientific student and investigator tables are given showing how the above results are reached. The digestion work covers feeding with soy soja) bean hay, cat-tail millet, Johnson grass hay, sorghum fodder and bagasse, peanut vine hay, cotton seed meal, cotton

seed hulls, crimson clover hay, corn meal, cornand cob meal and corn silage.

No. 98. Some Leguminous Crops and Their Economic Value; pages 24. Gives the result of the year 1893, with a great many varieties of clovers, cow peas, soy (soja) beans and other legumines. The bulletin includes discussions of legumines as improvers of the soil, their cultivation for forage and their fungous and insect enemies.

Field Peas.

The North Carolina Experiment Station during 1893 had under competitive test plats of cow peas and soja beans—ten varieties of the former and eight of the latter. The experiment has been completed and the results are published in bulletin No. 98, which is now being mailed in time to benefit farmers who sow these crops n spring. Here it may be said that the "unknown" pea has upon dry, medium and wet soil given by far the best results, out yielding all others, both in fruit and foliage. This pea is also the latest to mature. For second place the contest is between the black pea and the red ripper, both of which are excellent and medium early. The earliest of all is the speckled or whippoorwill pea. The "unknown" in Georgia, sometimes called innominata, and Woods' "wonderful," are in all respects identical—they are one and the same variety.

In the soja bean class, the old yellow variety is the most productive, both in fruit and foliage, but is much later than some of the newer variety.

Concerning the popular names of these plants it may be said that the so-called cow pea is not a pea, but a bean and is more properly called Chinese beans. The so-called soja bean is a true pea, and should be called soy pea, or Japan pea. But by whatever names we call them, these plants are among the most valuable crop the southern farmer can grow.

GERALD MCCARTHY,
Botanist N. C. Experiment Station.

Cabbage Insects.

Probably the worst pest of the cabbage field is the so-called calico or terrapin bug, murgantia histrionica. This pest is practically proof against known insecticides and must be hand picked. This is most easily accomplished by half filling a shallow pan with water, and pouring upon this a ¼-inch layer of kerosene oil. Hold the pan under the plant and shake or jar the plant. The bugs will readily drop into the pan and be instantly killed by the oil. As pure kerosene will burn the leaves badly it must not be splashed on them. The green and striped worms which gnaw the leaves of cabbage may be destroyed by the kerosene emulsion, and the cabbage lice can be held in check by the same remedy.

KEROSENE EMULSION.

Kerosene oil, . . . 1 pint.
Soft soap, ... 1 quart.
Boiling water, . . 2 quarts.

Churn the mixture for ten minutes, until it becomes a thick cream. Then dilute with four quarts of cold water and use. Mixing with a stick will not do, because on cooling the oil will separate and rise to top. When well done the emulsion is stable. Do not dilute until ready to use. Paris green should not be used on cabbage. GERALD MCCARTHY, N. C. Experiment Station.

Advanced Monthly Summary of Meteorological Reports for North Carolina, February, 1894.

The North Carolina state weather service issues the following advanced summary of the weather for February, 1894, as compared with the corresponding month of previous years.

TEMPERATURE.—The mean temperature for the month was 43.8 degrees, which is 0.5 degrees below the normal. The highest monthly mean was 50.9, at Sloan; lowest, 33.6, at Blowing Rock. The highest temperature was 76 on the 10th, at Wilmington; lowest, 2 below zero, on the 27th, at Bakersville. The warmest February during the past twenty-one years was in 1890, mean, 51.6; the coldest in 1875, mean, 38.4.

PRECIPITATION.—Average for the month, 4.82 inch, which is 0.57 above the normal. The greatest amount was 9.64 inches, at Highlands, least amount, 2.60, at Rockingham. The wettest February occurred in 1873—average, 9.03; the driest in 1890; average, 1.41. Snow occurred on the 4th, 5th, 14th, 15th, 16th, 25th, 26th, at some western stations, but on the 25th it was general, and the heaviest snow of the winter occurred. The largest monthly snowfall was 19 inches, at Bakersville.

WIND.—Prevailing direction' southwest. This is the normal direction for February. Average hourly velocity, 10.2 miles. Highest velocity, 48 miles per hour on the 1st at Kitty Hawk.

MISCELLANEOUS.—Sleet or hail occurred at various places on the, 2nd, 22th, 12th, 14th, 19th, 25th, all light. Solar halos occurred on the 10th, 11th, 13th, 17th, 20th, 22d, 23d, 28th. Lunar halos on the 7th, 10th, 11th, 13th, 15th, 18th, 19th. Meteor observed at Rockingham on the 17th.

QUESTIONS AND REPLIES.

The Station will be glad to receive questions on agricultural topics from

any one in North Carolina who may desire to ask for information. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Cotton Seed Hull Ashes.

Will you kindly inform me whether or not cotton seed hull ashes have ever been analyzed as a fertilizer by the Experiment Station, and what such analysis shows them to contain? F. A. D., Southern Pines, N. C.

[Answered by H. B. Battle, Director N. C. Experiment Station.]

I send herewith pamphlet on the subject of "composts," which gives analysis of cotton seed hull ashes. I would say, however, that analyses of these ashes vary very materially, because in many cases they are more or less burnt and more or less mixed with dirt or outside matters. Exposure to the air may also cause absorption of moisture and decrease of percentage. It is a very high grade potash material, containing a large amount of phosphoric acid as well. I have had an analyses of these ashes, when carefully burned, to run as high as 28 to 30 per cent. potash. The average is probably about 20 per cent.

How to Deal With the Potato Beetle and Cabbage Worms.

1. What shall I use to kill potato beetles?
2. If you advise Paris green with what shall I dilute it? Will ashes do? How put it on? How much Paris green shall I use per acre? Where is the best place to get it?
3. What is the best remedy for cabbage worms?
4. If kerosene emulsion, where can I get it, and at what cost? How is the emulsion applied?—W. C., Raleigh, N. C.

[Answered by Gerald McCarthy, Entomologist N. C. Experiment Station.]

1. The best remedy for potato beetles is Paris green or London purple, both being arsenites. They are about equally valuable. Mix 1 pound of either with 5 pounds of flour and 60 pounds of dry road dust, air slaked lime or fine ashes. If you have no sprayer apply with a sifter or perforated pan. If you have a sprayer, mix the arsenite in 150 gallons of water and spray it on. In either case repeat the treatment after ten days to kill the insects hatched after the first treatment. Usually these two treatments will suffice, but repeat if necessary.

For cabbage caterpillars, the arsenites are best before the plants have headed. After that hand pick or use a well prepared kerosene emulsion. A badly prepared emulsion will burn the leaves. It is best to buy the concentrated emulsion ready made. It can be bought in five, ten and forty gallon packages of W. S. Powell & Co., Baltimore, about as cheap as you can make it. Always dilute the concentrated emulsion before using with nine times its bulk of cold soft water. Apply with a sprayer, and be sure to wet the bodies of the caterpillars, as this substance kills by contact only. Paris green can be bought of almost any druggist at about 25 cents per pound.

Culture of Pecans.

Would you be so kind as to give me some information in regard to the culture of pecan nut trees, and at what point I can get the sprouts or trees to plant? B. G. G., Thermal City, N. C.

[Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.]

Pecan trees, like all other of the hickory family, are rather hard to transplant with uniform success. We would prefer to get good nuts and plant them where the trees are to grow. Almost any southern nurseryman can supply the seed or trees. P. J. Beckman & Son, Augusta, Ga., are nurserymen of high character, and will doubtless supply you with a good article. We put little confidence in the prospects of great profits from pecan growing on a large scale. It may now pay those well who have bearing trees of the large sorts to sell seed and trees at high prices, but the article is one which the demand for cannot be largely increased, and when the trees now being planted in the south come into bearing, we think the profit problematic. Of course it is desirable for all farmers to have a few pecan trees for ornament and nuts, but we would advise you not to rush too largely into the culture.

Proper Temperature to Churn—Profitable Poultry.

1. What temperature should butter be churned at to attain the best results?
2. Do you consider pure bred poultry, such as Plymouth Rocks and leghorns, much more profitable as flesh producers and layers than the common breed of chickens seen around most farms in this country?

G. F. O., Oakwood, N. C.

[Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.]

1. The temperature at which best results are obtained vary somewhat, first, with the season, being higher in winter than in summer; second, with the kind of foods given the cows, and, third, in different dairies where difference in handling the cream may affect the churning conditions. In winter, where cows are far advanced in lactation and considerable cotton seed or cotton seed meal is fed, as high as 70 degrees, F., or possibly two or three higher may be found desirable. In summer, with fresh cows on good pasture, as close to 60 degrees F. as possible will not be far wrong for the same dairy. Each one must establish its best degree of heat or coolness by actual trials. Too much

care cannot be bestowed on the proper "ripening" of the cream unless you churn more for rich buttermilk than butter.

2. Yes, unless you put a pure Plymouth Rock cockerel at the head of your flock of common fowls and continue to grade up with another from an outside source when the first is gone. The high grade birds will take on the characteristics of the pure bred male in proportion to his purity and prepotent powers. This plan will be easier for anyone who has common birds than breeding pure fowls, and they will have the advantage of (if there is any) the oft repeated claim that the graded stock is more prolific than that bred pure.

Grapes and Blackberries for Market.

Is there money in raising grapes for market? What are best varieties, how to plant, etc?

Will it pay to cultivate blackberries? How are they planted and cultivated? How many to the acre? Which is best variety? What the cost of planting? R. A. R. Vineland, N. C.

[Answered by W. F. Massey, Horticulturist, N. C. Experimeht Station.]

Would not advise planting grapes in your soil for market. You would be more troubled with rot probably than on higher and dryer land. The scuppernong for wine purposes is your best grape.

Blackberries will pay well if you are near the railroad and handle them right. Plant them 3x6 feet and tie to stakes and cultivate well, keeping down all suckers except in hill. Best variety is probably Wilson's early. The Early King, Early Harvest and Erin are good, and the Kittatiny is excellent when it does not rust. You can get plants at $8 to $12 per 1,000.

Benefit of Pea Vines to Land.

Kindly let me know what benefit you consider pea vines are to land, as compared with roots, etc., left after vines are cut off. The interest about here is first awakening to the restoration of old lands (and most all are now more or less so) by pea sowing. The time is near by when we will prepare land for wheat or fall oats, and are not fully together as to the good obtained by leaving the vines to be turned under, some contending that fully as good results can be had in crops that follow, by cutting the vines off for stock feed, the roots being worth more than the vine to the land. Do pea vines extract more from the air than any other plant? C. J. B., Middleburg, N. C.

[Answered by H. B. Battle, Director, N. C. Experiment Station.]

I am glad to know that the subject of planting cow peas is being revived in your section. As a sure renovator of old lands, it is one of the very best crops that can be grown. The cow peas have the same property as clovers and leguminous plants in extracting nitrogen from the atmosphere. This is done through the means of small tubercles on the roots which fix the gaseous nitrogen so that the roots can utilize it. In this way a large amount is retained in the roots, as well as carried to the leaves in organic combination. The plowing under of the whole plant, including vines after they are ripe, is, of course, better than plowing under only the roots, as there is much fertilizing matter in the vines and leaves. The ideal way would be to take off the vines, cure and feed to cattle, and return to the land in manure. The next best way would be to plow under after ripe, so that the fertilizing value of the whole plant is retained in the soil. The proportionate part of the total value in the vines is, of course, dependent upon the growth of the vines, and no fixed ratio can be given. I send bulletin No. 91, which describes experiments with peas preceding wheat. An increase of ten bushels per acre, approximately, has been secured by this method.

Location for Peach Orchard.

I have a plat of land lying on a hollow or ravine, and sloping westward. It is not very steep, but slopes gradually to the bottom of the hollow, which is somewhat level. The lowest part is about twenty feet above the water level in the nearest stream. The land is gray sandy land, and was originally covered with forest pine, but has a young growth of oaks growing on it now. In the spring the oak trees do not put out leaves until the leaves are at least half grown on the ridges all around. I think late frosts in the spring and early frosts in the fall are more severe than on the ridges. Would such a location be a good place to plant late apple trees? Would apple trees be affected by the location the same as the young oak trees? I have a lot of young peach trees seven or eight years old standing near the location I mention, only they are on southern and eastern slopes, and the frost kills the fruit on them every year. W. C. M., Lincolnton, N. C.

[Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.]

Your peach trees are in the worst place you could put them. In this climate peach trees should never be planted on a southern or eastern slope, but always on a northern or western. On the warm sunny slope they are excited too early and the blossoms nearly always killed. The crest and upper part of the north slope of a nigh ridge are the best places here for peaches. Peaches may do on the upper part of your western slope, and apples ought to do well on the lower part.

Fire Blight of Apple Tree.

I send you specimens of apple twigs from my orchard which were attacked last spring. The disease attacks both branches and twigs. In some cases only the twigs are killed, but in other cases large branches or the whole tree is dead. What is the cause and remedy? I also send diseased or blighted pear twigs. We had a hundred dwarf pear trees, but they are dying off one by one. J. S. H., Bowman's Bluff, N. C.

[Answered by Gerald McCarthy, Botanist, N. C. Experiment Station.]

The disease on both apple and pear trees is the same—the so-called fire-blight. This is caused by a species of bacteria micrococcus amylovorous. There is no remedy except destruction of affected parts. The disease is very contagious, and the cutting out must be promptly attended to or it will infect the whole orchard. Destroy by fire all dead branches.

THE EXPERIMENT STATION

At Raleigh, N. C., offers to Help the Farmers of North Carolina

APRIL 25, 1894.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the Station to all in the State who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefitted by them, please do not apply for them. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Adulterated Cattle Food.

Many people in North Carolina who feed stock, purchase wheat bran. In all the towns where there is no local mill, this bran is purchased by the ton or car load from western mills or wholesale dealers who have taken it from producers. Some of this bran gets to its consumers badly adulterated. Recently out of some bran purchased from a distant place and offered for sale at Raleigh was found the following: Unground kernels of wheat, oats, cockle, chess or cheat and several other varieties of weed seeds to the amount of 10,96 per cent of the whole on the supposition that all was like the sample pound drawn. Some of the light wheat kernels on examination were filled with a dark powder which was probably burnt or stinking smut (Puccinia rubigo-vera) one of the worst pests of wheat growing localities.

The cockle seed (Lychnis githago) was present to fhe amount of 2.77 per cent., or in other words this bran contained 55.4 pounds of cockle seed per ton of bran. Chess, or cheat, (Bromus secalinus) formed 1.01 per cent of the mixture called bran which held 20,2 pounds of chess per ton.

On the Experiment Farm where the stable manure has been weighed it was found that four mature horses with one colt, fourteen cows two bulls, one old steer and three swine produced fifteen tons of stable manure per month. At a moderate estimate for bran 2 1-4 tons would be consumed by this stock per month. Thus the 15 tons of stable manure would be stocked with seed enough to insure a fair stand of weeds. Those who feed this kind of bran should invest in weed killing implements, for they are sure to be needed, not only this year but continually for some time.

There ought to be a penalty for adulteration, especially where the foreign matter may do as much harm as weed seeds are capable of doing. This practice should warn purchasers to be particular to buy by sample and to accept nothing poorer than was shown in sample. It makes an argument for an honest local miller. who if he offers weed seeds will tell you what you are buying and grind them, so you will not be burdened by future weed crops.—F. E. Emery, Agriculturalist N. C. Experiment Station.

A Good Mixture for Tobacco.

Acid phosphate. cotton seed meal, nitrate soda. and sulphate of potash can be mixed to make a high grade fertilizer suitable for yellow tobacco, as follows:

Acid phosphate 13 per cent.	1200	lbs.
Cotton seed meal	575	"
Nitrate of Soda	100	"
Sulphate of Potash	125	"
Total	2000	"

This mixture will analyze approximately 8.5 per cent of available phosphoric acid, 3.4 per cent. ammonia, and 3.6 per cent. of potash. These ingredients should not cost more than $23.00 for the ton as above mixed. and the mixing can be done at a norminal cost at home. Its vaiue in a great degree depends on careful mixing. The materials should be made fine by mashing and mixed a short while before use. The ammonia is from two sources, cotton seed meal and nitrate of soda, and the latter is of special value for a quick growing plant as tobacco. The potash is in its best form for yellow tobacco as considered by long usage. The advantage of home mixing is that you can alter the proportions to suit your individual needs.—H. B. Battle, Director, N. C. Experiment Station.

Advanced Monthly Summary of Meteorological Reports for North Carolina, March, 1894.

The North Carolina State Weather Service issues the following advanced summary of the weather for March, 1894. as compared with the corresponding month of previous years:

The past winter has been a mild one in North Carolina. The month of January was three degrees above the normal in temperature, and February only half a degree below. The rain-fall was

deficient in January and March, and about half an inch above the normal in February. The conditions were generally favorable for farm work. The weather during March was very unfortunate for agricultural interests. From the 1st to the 26th the temperature averaged twelve degrees per day above the normal, reaching on the 22nd a maximum of 91 degrees at Southern Pines, and 89 at many other places; temperatures so high were never before recorded in North Carolina during March. Vegetation was pushed from two to three weeks in advance of season. The severe freeze of March 27th, and 28th, consequently did enormous damage everywhere. Undoubtedly the peach crop is ruined, but there will be a small yield of other fruits, especially apples. Grapes also were badly damaged, but will grow out again, producing something like half a crop. A good many strawberries were saved by covering, as were also some potatoes in the Eastern District. The loss of truck was very great, but a good deal of planting is done very early, with the expectation of having to replant, which is often done several times a season. Reseeding is well under way, and there is time for good crops. Wheat, oats, rye, tobacco plants and clover were also more or less damaged by the freeze. Notwithstanding all this there are many reasons for encouragement at the beginning of the season of 1894.

TEMPERATURE.—The mean temperature for the month was 54.3 degrees, which is 6.3 degrees above the normal. The highest local monthly mean this month was 59.6 at Wilmington; lowest, 45.2 at Blowing Rock. The highest temperature was 93 degrees, on the 22d at Washington, lowest, 4, on the 27th, at Highlands. This was the warmest March during the past 22 years, the highest monthly mean temperature previously recorded being 54.0 degrees, in 1878. The coldest March occurred in 1872, mean, 43.1,

PRECIPITATION.—Average for the month, 2.05 inches, which is 2.85 inches below the normal. The greatest amount was 4.77 at Falkland; least amount, 0.67 at Marion. The wettest March occurred in 1884, average, 8.50 inches; the driest in 1893, average, 2.15 inches. Very little snow occurred; largest amount, 2.0 inches, at Louisburg.

WIND.—Prevailing direction, South west, which is the normal direction for March. Average hourly velocity, 8,7 miles. Highest velocity, 52 miles an hour from the northwest on the 29th at Hatteras.

MISCELANEOUS.—Thunderstorms occurred at various places on the 9th 11th, 12th, 14th, 15th, 16th, 17th, 18th, 21st. 22nd, 23rd. Light hail, on 7th, 10th, 12th, 14th, 15th, 17th. Snow, 25th, 26th, 29th. Aurora on 30th. Very severe cold wave on the 27th; seriously damaging crops, especially fruit and truck.

Bulky Portions of a Fertilizer.

The question is often asked. "What are the other ingrediants of a fertilizer not included in the analysis as published and may not the pure materials given in the analysis be purchased alone, and a great saving in freight be effected?

Take for an example a fertilizer with 9.64 per cent available phosphoric acid, 2.39 per cent. ammonia, and 3.05 per cent. potash. These three added together only makes 15.08 out of 100. Of what is the remaining portions, or 84.92 parts? The table below answers this question.

Moisture	16.30	parts per 100
Available phosphoric acid	9.64	" "
Insoluble " "	1.68	" "
Nitrogen (in the ammonia)	1.97	" "
Potash	3.05	" "
Volatile and organic matter	30 00	" "
Sulphate of lime	15.00	" "
Lime (combined with phosphoric acid)	11.00	" "
Silica	3.00	" "
Chemical salts	5.00	" "
Miscellaneous	3.56	" "
Total	100.00	parts per 100

The above represents an Ammoniated Fertilizer. The moistureand organic matter are necessary to accompa'y the material furnishing the nitrogen (or ammonia.) Nitrogen is a gas and must be held in combination, and considerable bulk is necessary, depending on the kind of material used. Lime must be present combined with phosphoric acid, and sulphate of lime is derived from the union of sulphuric acid added to the phosphate of lime to make it more soluble. The chemical salts are generally combined with the potash. The silica is found with the phosphate. An acid phosphate is made up of phosphoric acid combined with lime suphate of lime (the largest constituent) necessarily present as explained above, moisture, and miscellaneous.—H. B. Battle, N. C. Experiment Station.

North Carolina Weekly Weather Crop Bulletin.

The first crop bulletin of the State Weather Service of the N. C. Agricultural Experiment Station, co-operating with the U. S. Weather Bureau, was issued from the central office in Raleigh April 9th. It is mailed on Monday, covering the previous week, to all newspapers of the State in time to reach the papers just going to to press. There are now over 300 correspondents located in every one of the 96 counties, sufficient to give very accurate summaries

of the effect of the weather upon the crops as to rain-fall and temperature, and the general condition of the staple crops, trucking crop, fruit industry, etc, in various sections of the State. To facilitate comparison the State is divided into the eastern district, central, and western. The bulletins will be continued each week during the growing season, ending about October 15, and will be sent free to applicants who after reading them, will agree to post the bulletin in a conspicuous place.

Spraying Orchards and Vineyards.

The general destruction of the fruit crop this year by the March freeze will make fancy prices for those who have been able to save a part of their crops. While the fruit buds of peaches, plums and blackberries are nearly all destroyed, of grapes we may still expect from 1-3 to 1-2 an average crop, and of late apples and European pears a nearly full crop.

Many fruit growers will be discouraged and think it not worth while to fight fungi and insects this year. This is very unwise even where there is no prospect of fruit for the present year. If these pests are allowed to multiply and spread without hindrance this year they may get such a firm foothold in an orchard or vineyard that it may take years to dislodge them. The more tender kinds of trees and vines are more or less enfeebled by the frost and these will be attacked with special virulence by the pests. Unless aid is given by the owner the pests may completely destroy the attacked plants this season. The only safe plan is to start the sprayer as usual and keep it going as long as any signs of noxious insects or fungi appear. Full directions for spraying fruit trees and vines are given in Bulletin 92 of the North Carolina Experiment Station which is sent free to residents of the State and to non-residents who send 10 cents in stamps.—Gerald McCarthy Botanist, N. C. Experiment Station.

Dehorning Cattle or Calves.

This is a humane practice wherever a number of animals are to be kept together. There is always more or less friction between different animals and the stronger are inclined to crowd and hook the weak or fight among themselves for the mastery. Dehorning not only checks this in part, but it prevents personal harm being done to some animals, while it frees the majority from the fear of the master animals in the herd.

We have successfully used the dehorning clipper made by the Leavitt M'f'g Co., Hammond, Ill. This is a safe, rapid method, and for adult animals no one wants a more rapid way of removing horns. No harm results to the animal. We have taken off horns during warm weather and in early winter with uniformly good results. No application after removing the horns in needed, though if in warm weather and there is fear of flies, a little carbolic acid may be sprinkled over the stub and surrounding hair to keep them away by its strong smell.

If it is desired to prevent horns growing in young animals, hair can be clipped from the point where the horn is about to appear, and the horn stopped by the use of a little caustic potash. Take a dry stick of potash and touch to water, then rub on the little protuberance where the horn is coming. Repeat a few times and the horn is killed. It has been known and recommended in bulletins and the public press for some time and belongs to the people if there is any value it. Recently we have been enjoined from using or spreading this information by a company claiming a patent right to sell and make a profit on all caustic potash used for this purpose.

If any of our readers wish to use potash to stop the growth of calves horns they need fear no evil will come to anyone if they buy the chemical from their family druggist, nor that they are infringing on any one else's right any more than to breathe the free air or drink at the roadside spring.—F. E. Emery, Agriculturist, N. C. Experiment Station.

QUESTIONS AND REPLIES.

The Station will be glad to receive questions on agricultural topics from any one in North Carolina who may desire to ask for information. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects, in this way, to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Blight of Tomato and Potato.

Can you tell me what is the reason I cannot raise tomatoes and Irish potatoes? The tomato vines flourish until the tomatoes are nearly ready to ripen, then they die. The soil is a rich light loam.

The potato vines flourish until they ought to have potatoes on them, then die. All the vines do not die, but when I dig them there are scarcely any potatoes, and what there are, are small and knotty.—J. F. H., Brinkleyville, N. C.

(Answered by W F. Massey, Horticulturist, N. C. Experiment Station.)

Your plants suffer from the bacterial disease known as "Southern Blight."

which is the great drawback to tomato culture in all Eastern North Carolina. It is the same disease that effects the Irish potato, a near relative of the tomato, It also attacks watermelons to some extent. The first sign of it to an ordinary observer is the sudden wilting of the whole plant, usually after it has developed to a good size. But before it reaches this stage watery spots can be found on leaves and stem, that under the microscope are found to be swarming with bacteria. If one of the wilted plants is cut off you can see with the naked eye that the growing tissue under the epidermis or bark is brown and dead. We will experiment with spraying mixtures to prevent it this season and hope for good results. Tomatoes are more liable to it than Irish potatoes, and potatoes along-side of tomatoes will be affected more than those removed from the tomatoes. It is recommended to spray with Bordeaux mixture from a very young state of the plants in the seed bed until they are in full bloom, about three times. We would advise making the Bordeaux mixture weak, at least for first spray, say 50 gallons of water. For potatoes, spray the potatoes before planting, as soon as up, and again when in bloom. When a tomato plant shows signs of the disease pull it up and burn it at once. Avoid planting where these plants grew the year before.

Cultivation of Cranberries.

I have an acre or more of marshy land almost entirely and continually covered with water. Soil entirely vegetable; yielding willow, bottom bush, wild rose. water grass, etc., is on the north side of a hill and subject to freshet over flow. Will the cranberry likely thrive on such soil and situation at this altitude? If so, should I plant berries or plants? When? What distance apart? What depth if berries? What cultivation? General management of plants, etc.?—A. L. B. Stonhel, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

No experiments that we know of have been made in this latitude in the artificial culture of cranberries. They are indigenous to the high valleys of our northwestern counties, but their success in the lower part of the state is problematic. The preparation of a bog for cranberry culture is an expensive matter, more so in fact than for rice culture. The land must be thoroughly ditched so as to drain, and must be at the same time diked, so that it can be overflowed artificially, when needed, and protected from overflow at all other times. All bushes and all the grass sod must be cut off and removed, and the surface covered with sand. Cuttings of the vines, made by running them through a feed cutter, are planted in drills and kept well cleaned from all wild growth until they cover the land after which they take care of themselves, excepts as to overflowing and draining. Orange Judd Co., LaFayette Place, New York City, publish a book on cranberry culture.

Fire Blight of Apple Tree.

I send you specimens of apple twigs from my orchard which were attacked last spring. The disease attacks both branches and twigs. In some cases only the twigs are killed, but in other cases large branches or the whole tree is dead. What is the cause and remedy? I also send diseased or blighted pear twigs. We had a hundred dwarf pear tress. but they are dying off one by one.—J. S. H., Bowman's Bluff, N. C.

(Answered by Gerald McCarthy, Botanist, N. C. Experiment Station.)

The disease on both apple and pear trees is the same—the so-called fire blight. This is caused by a species of bacteria, micrococcus amylovorous. There is no remedy except destruction of affected parts. The disease is very contagious, and the cutting out must be promptly attended to or it will infect the whole orchard. Destroy by fire all dead branches.

Nitrate of Soda for Strawberries.

I would like to get a little information from the Experiment Station, concerning Nitrate of Soda on strawberries used as a top-dressing.

First. When is the proper time for application?

Second. Should it be applied in wet weather, or when the plants are dry?

Third. Is there any danger of killing or burning the plants with it?

Fourth. About how much to the acre?—J. C. J. Rocky Point, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

First apply the Nitrate 1-2 at two dressings—first as soon as growth begins; second when fruit is setting.

Second. Always apply in dry weather when the foliage is dry, never in wet weather.

Third. If the leaves are wet with rain or dew it will burn them if applied directly. Best plan is to scatter it on both sides of the row. It dissolves at once on the soil.

Fourth. Use 100 lbs., per acre, 1-2 at a time, as suggested.

Injury to Acid Phosphate by Marl.

Please inform me by return mail whether Marl will injure acid phosphate or not, if composted together? Will the lime in the marl destroy the acid in the phosphate and leave the phosphoric acid insoluble as though it had not been treated with acid or not?—J. C. M. Resaca. N. C.

(Answered by H. B. Battle, Director, N. C. Experiment Station.)

Marl will have a tendency to injure Acid Phosphate. By its contrat with the soluble Phosphoric Acid in the latter, it will have a tendency to change it to the reverted Phosphoric Acid and finally to the insoluble, which are not so useful as the soluble form. I prefer, therefore, not to mix the two materials.

THE EXPERIMENT STATION

At Raleigh, N. C., Presents Some Matters of Interest.

Crimson Clover a Valuable Plant—A Fraud Exposed.

MAY 25, 1894.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the Station to all in the State who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefited by them, please do not apply for them. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Crimson Clover for Hay or Seed.

Crimson clover (trifolium incarnatum) is known under a variety of common names—Annual, German, Scarlet, and Italian. This clover is easily grown, and should come into quite general use. It is an annual, and consequently must be re-seeded for each crop, which makes it important to grow seed at home. Seed may be sown from July to October, but the land should always be well prepared for it, or, if not, it should be well shaded, as under a growth of cow-pea vines, or in a corn or cotton crop, where the seed should be sown when the crop is laid by. Grown in this way it may be of great service in enriching and holding the land from washing. Its growth is made in the cool, wet part of the year, and it is ready to be made into hay at a season when planters are waitin for cotton to vegetate for first working. This is often a dry time, and the hay can be quickly and easily cured. It may often be best to sow this clover with oats, rye, or barley, and cut all for hay in April or May.

This clover will thrive on land in moderate condition, but, like some other forage plants; will pay best where given a rich soil. The composition of crimson clover hay shows it to be a highly nutritious food. It is so rich that for any use it may well be fed with some such fodder as straw, meadow hay, or cotton seed hulls. When fed for production of milk, the addition of corn, or corn and oats, will tend to add to the good qualities of the product.

The seed distributed in 1893 by the N. C. Experiment Station is part of a crop of 2,687 pounds from 1 3-8 acres, which is at the rate of 1,956 pounds of seed in chaff per acre. We have made some tests on this, which if true for the whole lot of seed, would yield at the rate of 757.95 pounds, or 12 5-8 bushels per acre of clean seed. This seed usually sells at retail for ten cents per pound, and dealers are now paying $5.50 per bushel for it, The long, well-filled heads warrant this a good cash crop where a good stand can be secured on land in fair condition. It can be grown in orchards for the improvement of the soil, as in Delaware, where it has come to be a standard crop. The one drawback is that a special machine must be used to clean the seed. A clover seed huller is expensive, but could clean the seed of a whole township, and perhaps a whole county by moving around as is usual with threshing machines.

There are several advantages in growing annual clover sufficient to induce its cultivation from purchased seed; but if, instead of buying seed, it can be grown at a profit and add one more to to the cash crops, how much better to take such steps as will insure its general planting.

In maturing a crop of seed care should be exercised to pull out weeds and foreign plants and so keep the seed clean. Let the clover get ripe, but not so as to shell out too freely before cutting, and handle as little as possible. Pitch up into cocks from the swath and draw in from the cocks in tight wagons. If tough, the cocks may be turned over from the bottom a half hour before drawing to shelter. House on a tight floor and thresh out at the first opportunity after the straw has dried out enough to thresh well.—F. E. Emery, Agriculturist, N. C. Experiment Station.

Crimson Clover Seed Distributed in 1893.

The Experiment Station having on hand last year (in 1893) Crimson clover seed which had been grown on the experiment farm, offered through the press of the state to distribute to applicants who would pay transportation charges and who would make careful trial of same, enough seed to plant 1-3 acre. There were 1586 persons who applied for the seed, far more than the Station could supply, unfortunately. Indeed a quantity of seed had to be purchased to send as many as was supplied. The first 426 names received

were sent the seed. To others full explanation was given as well as at what points the seed could be procured. Replies regarding the test are now coming in and tend to show that widespread information has been given in regard to this most valuable forage crop, and much interest has been created in its cultivation.

Experiences With Crimson Clover.

Just now the Experiment Station is receiving a lot of varied but interesting information in relation to growing this plant from the farmers to whom seed was distributed last year. Brief directions for every step in growth of the crop were sent with the seed and the call for this information contains specific inquiries as to the various processes which help in studying the effect of preparation of soil in different sections of the state.

That the crop has been found all the Station claimed for it so far by some farmers is shown in the following report from Vance county:

"Grown on stiff red land in very good condition. Broken with two horse plow and harrowed with a Gayle harrow. Harrowed the seed in with same implement October 4th, or 5th, '93. The amount of seed used was 3 pounds cleaned, and it was put on 1-3 of an acre. No fertilizer was used except a dressing of tobacco stems after the clover came up. The clover started well, and continued to grow off well until injured by the March freeze. It has not been grazed but is now being fed green on the soiling system. I think it a splendid feed and will sow several acres this fall if I can get the seed. Think it would be better sown in August or September. I send herewith a specimen which I think is about an average stalk as it is very uniform and very thick."

The specimen was 26 inches long; the head 2 inches. 1-3 of the piece or 1-9 acre like it should produce seed enough for 5 or 10 acres, or enough if clean, to bring $10.—F. E. Emery, Agriculturist N. C. Experiment Station.

Another Fraud Exposed.

This time it is a seed fraud. The Station last month reported the serious adulteration of bran with cockle, cheat and other weed seed, and the inevitable result of feeding the bran, by which a clean field would rapidly become seeded with these obnoxious weeds, wherever the manure was put on the land.

A correspondent from Robeson county sends a seed package which reads as follows:

LATE CABBAGE.

Recommended by U. S. Agricultural Department as the best cabbage for the Southern States. Grown and warranted by the Junaluska Seed Co., Junaluska, N. C. Price, ten cents.

Our correspondent writes. "Sometime in the early part of this spring, an unknown man passed through this part of the state selling garden seed, and sold quantities of them throughout the county, but they have proven to be spurious and of no value to those who purchased them. Inclosed you will find one of the papers, also one of the plants. Can you tell us what it is? Thinking or believing that it was all right none of us asked the man his name, and have no redress. The plant sent by him was apparently the European wild cabbage used often to adulterate cabbage seed. A communication was at once sent to a reputable seed house in western North Carolina, and a reply was promptly received saying, "We hope you can help us run the rascals down. We have heard nothing from them this season, but last year we had many complaints from the eastern part of the State, and a friend sent us a seed bag. It was printed Cabbage Seed, grown by the Reems' Creek Seed Garden Co. We investigated the matter and found the parties had lived near Asheville N. C., but could not get their names to publish them. We think the Junaluska concern the same parties that swindled the people last year."

The rascals are smart because they do not give their names, and the post offices Junaluska, N. C., and Reem's Creek, N. C. are purely fictitious, for there are not now, and never have been post offices by those names.

The penitentiary is the best place for them. All persons are warned not to buy from such parties, and in fact let travelling seedsmen alone for there are enough reliable well established dealers in the business who cannot afford to misrepresent knowingly anything they sell. They count their reputation of far more value.—H. B. Battle, Director N. C. Experiment Station.

Advanced Monthly Summary of Meteorological Reports for North Carolina, April. 1894.

The North Carolina State Weather Service issues the following advanced summary of the weather for April, 1894, as compared with the corresponding month of previous years:

TEMPERATURE.—The mean temperature for the month was 57.3 degrees, which is 0.4 degrees below the normal. The highest monthly mean was 61.6 at Southern Pines; lowest monthly mean, 45.5 at Blowing Rock. The highest

temperature was 89 on the 28th, at Washington; lowest, 22 on the 7th, at Bakersville. The warmest April during the past twenty-one years occurred in 1886, mean 60.8; the coldest was in 1881, mean 53.9.

PRECIPITATION.—Average for the month, 1.75 inches, which is 2.09 inches below the normal. The greatest amount was 3.13 at Bryson City; least amount 0.65 at Sloan. The wettest April occurred in 1874, average 7.96 inches; the driest, in 1888; average 1.74 inches.

WIND.—Prevailing direction southwest, which is the normal direction for April. Average velocity, 9.8 miles per hour. Highest velocity, 46 miles per hour from southeast, on 10th at Kitty Hawk.

MISCELLANEOUS.—Thunderstorms occurred at various places on the 1st, 4th, 10th, 17th, 18th, 19th, 20th, 21st, 23rd, 26th, 27th, 28th, 29th. Light hail on 19th, 20th, 23rd, Frosts occurred on 2nd 3rd, 6th, 7th, 10th, 11th, 12th, 13th, 14th 16th.

The month was unusually dry.

Distribution of Soy (Soja) Beans.

The N. C. Agricultural Experiment Station at Raleigh, desiring to extend the cultivation of Soy Beans has proposed to distribute a quantity of seed to careful planters desiring to test their merits. The only condition is that each applicant send 10 cents in postage stamps to pay cost of transportation by mail. Enough seed will be sent to each applicant to plant 1-10 acre. The first 400 applications will be filled in the order received.

The Station regards this as a very valuable forage plant. It is of upright growth 2 to 3 feet high and is a legumine capable of adding nitrogen from the air to the soil in which it grows. It is planted in hills or drills 2 1-2 to 3 1-2 feet apart according to richness of soil, and 15 to 24 inches apart in the row. It can be planted any time from March to July, either alone or in the corn row between the corn, and 2 to 4 beans are usually planted in each hill. Soil suitable to it and the general preparation is the same as for corn. When planted for corn both crops can be ensilaged together, and the corn ensilage will be much improved by the combination, or the plants when planted alone can be cut for forage before they get too woody. The seed are found in small pods and can be saved by cutting the whole plant when leaves and pods have turned a golden hue. They can easily be beaten out when dry. If cutting is delayed beyond this time the pods will open and some will be lost on the ground. It will not pay to pick the beans. It is also a good table bean, but requires a long time to cook. The beans parched similar to coffee, has been used as an acceptable substitute, for it, and at far less cost. It has not the exact aroma of coffee, but is recommended as a cheap substitute probably just as good and in some cases better than the low grades of coffee after being adulterated with peas or beans with a value less than the soy bean. The Station urges a careful trial of this crop.

Directions for Cooking Soy Beans or Peas.

The following directions have been tried by Dr. J. H. Mills, of the Baptist Orphanage at Thomasville, N. C., and recommended by him:

Soak the peas until the skins come off, then stir the peas until the skins rise to the surface and skim them off. Boil the peas with bacon until soft. Add pepper and butter to suit and serve hot. If the peas are green, the preliminary soaking may be omitted. This makes a most palatable dish, well liked by the children.

Chicken Cholera and Its Prevention.

Why submit to heavy losses from this disease? Up to April, 1894, this disease had not been on the Experiment Farm to our knowledge. Early in that month a hen became sick and dumpish with dark comb; all food and water refused. It was thought useless to treat this case, but Epsom salts were administered and this was followed with copious watering put in the mouth with a spoon. The hen was placed in a warm, sunny place, isolated from usual runs, and recovered very slowly.

Another hen died in a few days and then another and a cockerel, and several persons who had had experience with cholera pronounced this disease to be cholera. The hen and cockerel died near night, and next morning two other hens were dead and eight more were in different stages of the disease.

Treatment was begun at once. Two hens were killed and buried as those previously dead had been. The six were brought out into the sunlight and given salts and water.

The house and yard were thoroughly disinfected with 1 pint of strong sulphuric acid to 8 gallons of water, as suggested in poultry books. The hens themselves were sprayed with this. Their drinking water was charged with carbolic acid (1 teaspoonful to half gallon water) and asafœtida was put in their food at the rate of 1 heaping tablespoon to the food of 30 chickens.

The next morning six hens could not get off the roost, though all but two had gone up as usual the night previous, after their treatment. These were treated as before and put outside the yard. Before night all but four

hens were walking about pecking grass. After three days of isolation these four were returned to the yard cured, and all have been in good health since. Six hens and a cockerel were lost before the health of the flock was restored by the treatment as given above.

Had we known the disease at first, it is doubtful if a single bird need to have been lost. Promptness to disinfect and treat the sick birds will save many losses. The doses of salts, not before recommended to my knowledge, doubtless helped rid the birds of the cholera bacilli sooner than if it had not been given, and so hastened the eradication of the disease. The asafœtida acts as a diffusible stimulant to help keep the birds warm.

The drinking water was for some days kept charged with carbolic acid, and all that is now needed to secure immunity from another attack is a second thorough disinfection and to continue for some time the addition of carbolic acid to the drinking water. F. E. Emery, Agriculturist, N. C. Experiment Station.

Questions and Replies.

The Station will be glad to receive questions on agricultural topics from any one in North Carolina who may desire to ask for information. Address all questions to the "N. C. Agricultural Experiment Station, Raleigh, N. C." Replies will be written as early as possible by the member of the Station staff most competent to do so, and, when of general interest, they will also appear in these columns. The Station expects in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Cultivation of Barley.

Please send me any information you can in regard to growing barley; the time and manner of seeding, etc. G. W. E.—Wilson, N. C.

(Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.)

Barley flourishes best in a moist, cool climate. Its short straw and stiff beards are against its introduction in places where it might be cultivated. However, there are beardless varieties, and they can be sown on rich land, which will force it to a maximum growth. Sown in August, it will, if not checked by drouth, produce a good late forage, which will continue growing after early frosts have checked other vegetation. Cut when heading out or soon after, before beards are hard; this makes a good green food, or hay, but will be slow to cure if cut late. The land should be well prepared and rich to grow a good crop of barley, as this, like the other small grains, is a gross feeder, and must have food at hand. Sow one to one and a half bushels per acre, or, where a thick stand for forage is required, two bushels may not be too much. The fertilizer should be a previous crop of clover, cowpea vines or other legume, or a complete chemical manure, with a rather high percentage of nitrogen if on poor land. For a grain crop, winter or the earliest possible spring sowing would seem preferable, hence from December to February would be about the right time to give this crop a natural development and have the grain ripen normally and when it can be easily harvested.

Cucumbers for Pickles.

"I write to ask some information for growing and packing cucumbers for pickles for the fall and winter market.

I would like to know the best kinds of cucumbers to plant for making pickles of small size to pack in barrels and kegs and the best kinds for making very small pickles to pack in glass. Also which is best, to plant in hills or drills and distance of same. Also the full process of packing the cucumbers in barrels, kegs and glass and kind of vinegar to be used and any other information that may be at your command.—J. S. S. Salem, N. C.

(Answered by W. F. Massey, Horticulturist, N. C., Experiment Station.

"Cucumbers for pickling are generally grown by gardeners as a second crop after some early crop has been harvested. The seed are planted late in July in well manured hills four and one-half to five feet each way, and cultivated like cantaloupes. They should be cut when the length of ones finger, or even smaller for bottling pickles. Cucumbers should always be cut, never pulled, so as to have a portion of the stem attached. The vines should not be handled when wet with dew. If not shipped at once, or sold to a pickling factory, they should be dropped in strong brine and kept under the brine until ready to pickle. Long green and white spine are the sorts commonly grown. We prefer the long green or Nichol's medium green For process of pickling we will have to refer you to the cook books.

Shells and Lime.

"Please state the difference between shell and other lime. Are shells reduced to lime by burning?—W. H. L. Princeton, N. C.

(Answered by H. B. Battle, Director, N. C. Experiment Station.)

Shell lime is merely shells burned. Rock lime or stone lime is the crude limestone after it has been burnt. The combination in all the crude materials is carbonate of lime, which by the action of heat is changed to the oxide of lime, or caustic lime; building lime is also the caustic lime. Marl contains refuse of shells and consequently has a varying percentage of carbonate of lime.

THE EXPERIMENT STATION

At Raleigh, N. C., Describes Some of Its Work.

A Few Late Bulletins, Ever Bearing Mulberries—Some New Forage Plants—Questions and Replies,

June 1894.

The Experiment Station Bulletins.

The standing offer is made to send the bulletins of the station to all in the state who really desire to receive them. Thousands of farmers have already taken advantage of this offer. Unless you really want to be benefitted by them, please do not apply for them. If you desire to read them, write on postal card to Dr. H. B. Battle, Director, Raleigh, N. C.

Ever Bearing Mulberries.

The botany of the mulberries is much mixed. They all belong to the genus morus, except the tree known as the Otaheite or paper mulberry, which is a Broussonettia. This tree is seldom found fruiting here as the vast majority of those grown on the staminate or male trees—morus multicaulis, the Chinese silk worm mulberry—caused a great excitement in this country fifty years or more ago, with a great craze over silk culture. From this species Charles Downing raised the variety known as Downing's ever-bearing, which produces a large and very good fruit, but as it lacks hardiness in the north is now grown only in the south. There are three classes of mulberries, the white, black and red, but they sport greatly, for white mulberries frequently give black fruit. A species from Russia, the Tartarian mulberry, is largely used for hedging in the northwest. There have been many varieties raised from the foreign species, besides that of Mr. Downing—and several from our native red mulberry. The most promising of these native sorts is the Hick's ever-bearing. This variety was first introduced by Mr. Rose of Macon, Georgia, as a tree for furnishing cheap and abundant hog food in summer. It is a very profuse and continuous bearer for three to four months, and is as valuable for chickens as for hogs.

It is stated that the Stubbs mulberry, which was sent to Mr. Berckmans, the nurseryman of Augusta, Ga., by Colonel John M. Stubbs, of Dublin, Ga., is the most prolific of all, even exceeding the Hicks. It produces fruit jet black and fully two inches long, and is very good table fruit. Mulberries are easily grown in the south from ripe cuttings a foot long set in the ground full length in the fall. An orchard of the Hick's or the Stubbs will be found a profitable adjunct to every southern farm providing succulent food for hogs and poultry until the pea fields are ready—or the sweet potatoes are grown.—W. F. MASSEY, Horticulturist, N. C. Experiment Station.

Three Forage Plants For Sandy Soil.

Among the plants suitable for very dry sandy soils, the three best forage plants are Spurry (spurgula arvensis) Seradella (ornithopus sativus,) and Sulla, (Hedysarum coronarium.)

SPURRY, belongs to the pink family, which includes besides the garden pinks the very common weeds, chick weed, mouse ear and sandwort. From an economic standpoint, this family is far from promising and Spurry is the only genus which has been found of use as a forage plant. Animals refuse this until they get used to it, and then seem to like it. The plant is highly valued for sheep and cow pastures on the sandy heath lands of Holland and Belgium. It is thought to give a superior flavor to butter and to the flesh of sheep. Spurry has been tested on a large scale on the pine barrens of northern Michigan and is very highly recommended for that section. It has been tried in a small way in some of the southern states, but with no great success. If it has any value for the Carolinas it will be for the long leaf pine district. For good average land some of the leguminés will give better satisfaction. Spurry may be sown broadcast, using about 6 pounds of seed per acre, any time from March 1st, to September 1st. The plant grows about 12 inches high and is very prolific in seeds, Spurry seed posesses great vitality, and the plants usually break ground 3 days after sowing the seed. The subsequent growth is rapid and the plants may be pastured in 6 weeks or mown for hay 8 weeks after sowing the seed. This plant seeds so heavily and the seed has such great vitality it is liable to become a more troublesome weed than chick weed in cultivated ground. It should

not be used except on land too poor to produce a better crop.

SERADELLA is a member of the great and eminently useful pulse family—including the clovers, peas, beans etc. Like all the members of this family, Seradella is able to draw upon the free nitrogen of the atmosphere and hence for green manuring is superior to Spurry. This plant is a native of Portugal and is there highly esteemed as a forage crop for sandy soils. Seradella is an annual, grows about 24 inches high, seeds fairly well and the herbage is easily cured for hay, and well liked by stock. Seed may be sown broadcast about April 1st. using 20 lbs per acre. The growth is much slower than that of Spurry, and only one crop can be grown in a year.

SULLA, (Hedysarum coronarium) is also a legumine and is a native of Spain. The uses and value of this plant are much the same as Seradella but it is somewhat inferior to the latter.

All three plants above described can be recommended only for very poor sandy lands or where no fertilizer can be afforded. When the land will bring a good crop of cow peas, or soy peas these latter are the better plants to grow either for forage or green manure.—GERALD MCCARTHY, N. C. Experiment Station.

Recent Bulletins of the N. C. Experiment Station, at Raleigh N. C.

The following bulletins recently issued by the N. C. Experiment Station will prove of interest to farmers. They will be sent free to those applying for same in North Carolina; to others a small charge of 4 cents each will be made. Apply to the director, Dr. H. B. Battle, at Raleigh, N. C., for them

BULLETIN 96. Miscellaneous Agricultural Topics, contained in the press bulletins. 32 pages. A popular bulletin containing a variety of articles contributed by the Station to the press, during the last half of the year 1893. All of these subjects are treated in a popular way, and in untechnical language as far as possible. About 80 farm questions are so considered.

BULLETIN 97. Digestion Experiments. 48 pages. In order to arrive at the true value of many of our common feeding stuffs, so they can be more economically and rationally fed, these actual digestion experiments have been conducted. Animals are fed with the different foods and rations, the amount of food eaten and water drank being carefully recorded, the amount of excrementitious matters are also ascertained and analyzed and compared with the analysis of the food eaten. The difference in the two affords means for estimating the quantity of materials actually digested and utilized by the animal. Preliminary pages are given describing in detail the digestibility of foods, and digestion experiments, the terms used, the animals employed for the test, and the different rations employed. A summary of results is next given for popular understanding. These portions of the bulletin occupy 16 pages; the remaining 32 pages relate to the details of the work and are not sent except where especially desired. The foods experimented with are soy (soja) bean hay, cat-tail millet, Johnson grass hay, sorghum fodder, peanut vine hay, sorghum bagasse, (residue after juice is extracted from cane,) bagasse and cotton seed meal, one year old crimson clover hay, same hay with cotton seed meal, cotton seed hulls and meal, with large proportions of meal, corn silage and cotton seed meal, corn meal, crimson clover hay and corn meal, corn and cob meal, crimson clover hay and corn and cob meal.

BULLETIN 98. Some Leguminous Crops and their Economic Value. 40 pages. These crops have especial value because they take out that valuable gas from the atmosphere (nitrogen) and store it up in their roots to be utilized in their growth, and for future crops on the same soil. When we buy nitrogen in a fertilizer it costs us about 18 cents a pound and it is needed by nearly all crops. These crops get this material for nothing. All good farmers should therefore be sure to utilize these natural benefactors, for they are of great value to mankind. The clovers, cow peas, and soy bean are the best of these crops. Chapters are devoted to legumines as improvers of the soil, the cultivation of leguminous plants for forage, and the fungous and insect enemies of legumines. The crops tested included, lucerne, hybrid medic or sand lucerne, black medic, sulla, seradella, kidney vetch, japan clover, soft tick seed or beggar weed, yellow lupine, common vetch, woolly vetch, hairy vetchling, improved flat pea, false vetch, goober pea, giant white clover, red clover, mammoth clover, zig-zag clover, crimson clover, Southern cow pea (10 varieties). Japanese pea (3 varieties) and Japanese bean (2 varieties). The best of the cow peas are in the order named, the "unknown" or "wonderful" (the same variety,) the black, the red ripper, the whippoorwill, and the conch.

BULLETIN 99. Thread Worm of Pork, 8 pages. A popular account of this worm or Trichina spiralis, showing its various life stages, and how they become dangerous to human life. All eaters of

pork should understand the danger and how it can be averted, which is easily done by cooking well all parts of the meat to at least a temperature of 175 degrees, F. Pork is seldom affected in this way, which is fortunate, but we ought to adopt measures to prevent the worm from getting into our system, even when we are unconscious of its existence in the pork we eat.

BULLETIN 100. Our Common Insects. 36 pages. A bulletin to describe the scientific classification of insects, so that school children may become acquainted with the various insects and know how to distinguish between noxious and beneficial insects. If the children's interest is aroused, the interest of their parents is at the same time secured.

A New Potato Pest.

Several complaints have reached the station from Columbus county concerning the ravages of a hitherto unnoticed insect upon growing Irish potatoes. Mr. A. B. Smith, of Armour, N. C., writes: "Thousands of these bugs have suddenly appeared on my potatoes, there being an average of three or four to each plant. They do not eat the leaves but puncture the growing tip causing the plant to wither and soon die. What is it and what shall I do for it?" Mr. J. B. Chadbourne of the same county sends specimens and writes in much the same strain.

The insect is Leptoglossus phyllopus a true bug closely related to the predaceous Thick-thighed Soldier bug-Acanthocepholis femorata. This insect is not common in this state and has been considered beneficial because it feeds upon thistles and occasionally attacks the terrapin bug of the cabbage. In Florida it attacks the orange: Now that it has changed its diet from thistles to potatoes, it is likely to become a troublesome pest.

REMEDIES.—As this bug does not gnaw the foliage it can not be poisoned by arsenites. The only remedies are the kerosene emulsion and hand-picking. The latter will prove upon the whole most satisfactory. Use shallow pans containing some water and film of pure kerosene. Hold the pan under the vines and jar or shake the bugs into it. The best time to do this is before sun rise in the morning while the insects are still torpid.—GERALD MCCARTHY, Entomologist, N. C. Experiment Station.

Questions and Replies.

The station will be glad to receive questions on agricultural topics from any one in North Carolina who may desire to ask for information. Address all questions to the "N. C. Agricultural Experiment station, Raleigh, N. C. Replies will be written as early as possible by the member of the station staff most competent to do so, and when of general interest, they will also appear in these columns. The station expects in this way to enlarge its sphere of usefulness and render immediate assistance to practical farmers.

Raising Cabbage for Market—Onions.

Do you think I could make it pay raising cabbage for the markets of Danville, Richmond, etc.? (I mean, could I get them early enough from this section?) Do early onions pay any better than late ones? Is the Prize-Taker onion any better for the old way of culture than Yellow Danvers? C. S. W.—North Wilkesboro, N. C.

(Answered by W. F. Massey, Horticulturist, N. C. Experiment Station.)

I doubt that you would find profit in growing early cabbage for the Richmond or Danville markets in your section as the eastern part of the state gets them so much earlier. But it will pay on the rich bottom lands of the Yadkin to grow late fall and winter cabbage for Raleigh and the southern market. Early onions, bunched, grown in March pay better than ripe ones. The first ripe ones in the market bring better prices than later in the season when the onions from the north and west come in. The Prize-taker onion is larger than Danver's Yellow. If you mean by the "old way" to grow them from sets, you will find little difference in them; but it is entirely needless to go to the expense of sets to raise a crop of onions, as by early sowing you can grow as good, or better, a crop from seed the same season. Sets are only useful for fall planting to raise early grown onions for bunching.

Remedies for Borer of Peachtree.

Will wrapping the base of a peachtree in tarred paper keep the borer out?—W. M., Speight's Bridge, N. C.

Answered by General McCarthy Entomologist, N. C. Experiment Station.

Wrapping the base of trunk will prevent the female borer moth from laying her eggs on the collar of the tree if the paper is wrapped sufficiently tight to keep the insect from crawling down between paper and bark. This is difficult to do, and therefore the treatment is not reliable. Mounding, or use of washes recommended in Bulletin 92 of this station, are much more satisfactory.

Grass For Permanent Pasture.

I have some muck, or meadow lands that I desire to convert into permanent pasture. Will you please inform me what variety of grass will be most suitable for swine and cattle, when to seed, how long before stock should be turned on after seeding?—J. F. H., Godsboro, N. C.

Answered by F. E. Emery Agriculturist, N. C. Experiment Station.

1. For permanent pasture, Kentucky blue, red top, with white clover and Bermuda grass is the best possible combination. Use as much as one and a half bushels per acre of the first two, three to five pounds of clover and one bushel of Bermuda grass seed, or cuttings of the stems raked from gardens can be used. Cut them in any feed cutter, and sow broadcast and harrow in. Eight or ten bushels of cut stems will not be too much to sow per acre. 2. If the land is dry enough plow and sow to cow peas. Turn down the pea vines as soon as they are ripe and sow the seed; rye may be sown, too, if desired and this will shorten the time to turning on stock. If land is in good condition it could be sown without the aid of the pea vines in dog days—with the assurance of a good stand of plants. 3. Stock may be turned on only after the plants have made growth enough to well cover the ground and the turf is firm enough to support the animals without much injury. Too early grazing will work a permanent injury to the pasture. Better wait till the rye begins to head unless the growth is very luxuriant.

Nitrate of Soda and Ashes.

Would there be any loss of ammonia in mixing nitrate of soda with unleached hard wood ashes to use as a top-dressing for strawberries. I wish to give the nitrate more bulk and the ashes are sooty. The ammonia in the nitrate being in a non-gaseous form I take it that the same harm would not follow as from mixing ashes with stable manure.—O. W. B. Kittrell, N. C.

Answered by H. B. Battle, Director, N. C. Experiment Station.

The addition of ashes to nitrate of soda will not be objectionable. I assume that you will wish to apply just after mixing. There might be some change if the mixture is allowed to stand over some time.

Crimson Clover, Timothy, Bermuda Grass.

I am anxious to sow some grasses and clover on my farm in Bertie county this fall and write for some information. When is the best time to sow crimson clover, and how much per acre ought to be planted? Can any grass seed be sowed with it that will mature at the same time? If so, what kind? What kind of guano is best to apply and how much per acre for best development of this crop? Is it best to put the fertilizer under, or as a top dressing? I have a piece of deep soil thickly set in Bermuda grass that I wish to sow, will it interfere with the growth of the other grasses, or clover? When ought Timothy to be sowed and how much per acre? What kind of grass seed or clover is best to sow with it?—J. H. E., Littleton, N. C.

Answered by F. E. Emery, Agriculturist, N. C. Experiment Station.

On moist loam or sandy land any time in September is considered the right time to sow crimson clover. Here on dry land it must be sown early enough to get the benefit of the moist weather which is ushered in by dog days. In general whenever the next two or three weeks can be counted on for plenty of moisture and shade. Twelve to fifteen pounds of clean seed or thirty to forty pounds of seed in chaff is enough to use per acre if well distributed, as this crop stools heavily when it has a good chance. Sow on the surface or cover very lightly. Few grasses can mature with crimson clover. Common rye, or even Italian rye grass may be sown with crimson clover when the design is to cut for green food or hay. These can about keep pace with the clover. We would use one half bushel of rye or one bushel Italian rye grass per acre with eight to twelve pounds of the clover seed.

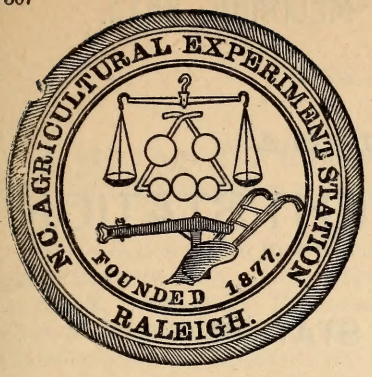
Clover finds its own nitrogen by extraction from the atmosphere aided by peculiar microbes of the soil hence only phosphates and potash, or lime to set these free in the soil would be needed. The needs of the particular soil should be consulted as to the element it lacks which is needed to produce a bountiful crop of clover. Hence trials of potash, phosphate and the two combined would be in order wherever it is desirable to use chemicals for this crop. Amounts should be varied, too, as what would be a profitable amount for one field or farm might prove too little or too much for those adjoining. We would broadcast before or after the harrow at seeding or use as a top dressing a little later.

Bermuda grass will smother out some of the grasses but the soil bearing it will probably be your best place for Timothy. For ordinary sowing, orchard grass is hardy and a rank grower and will beat Timothy, but it gets woody if not cut early and has not so good a reputation for hay, although properly handled it is equally as good or better and of the same character. It is one to three weeks earlier than Timothy. Sow two bushels per acre, and with it two bushels Kentucky blue grass and six pounds common red clover. Of Timothy eight to ten pounds of seed with six to eight pounds of pea vine clover would be fair seeding on the Bermuda grass soil. Where the Bermuda is absent we would add four or five pounds of white clover seed, or two bushels of meadow foxtail, to furnish aftermath to protect the Timothy bulbs from the sun, otherwise it would be in danger of destruction after first mowing. It would be well to grow a crop of pea vines this summer to plow in for the grass seeding. Plow deep, turning the vines well under when nearly or quite all ripe; harrow to a seed bed without disturbing the vines and sow the seed then whether August or as late as November.

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August 18, 1894.

North Carolina

Agricultural Experiment Station,

Bulletin No. 104.

WHY PULL YOUR CORN FODDER?

Publications will be sent to any address in North Carolina upon application.

N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA
AGRICULTURAL EXPERIMENT STATION

INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

UNDER THE CONTROL OF THE

BOARD OF TRUSTEES OF THE A. AND M. COLLEGE.

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RALEIGH, N. C.

WHY PULL YOUR CORN FODDER?

By F. E. EMERY, Agriculturist.

A year ago the following article appeared in the press bulletin service of the Station:

There is a serious loss in harvesting corn in the usual way of pulling fodder and plucking the ears. Some recent Experiment Station work serves to bring this out in relief. Mr. J. H. Patterson, of the Maryland Station, publishes some matter showing the location of the dry matter of the corn plant in three crops examined. Co-efficients of digestibility are given, with composition and total digestible product of ears, topped fodder, blades, husks and stubble. The results show the ears and blades to have been only 50.59 per cent. of the dry matter of the crop. The other parts, usually neglected by our farmers, consequently amount to 49.41 per cent., or at least one-half.

Of the digestible matter, 55.08 per cent. only was contained in ears and blades. Thus nearly 45 per cent. of the digestible matter of the crop would be lost by taking only ears and blades from the field.

The digestibility of coarse fodder, rich in carbohydrates, is greatly increased by feeding with highly nitrogenous materials, such as cotton-seed meal. So it would be possible for one to get almost as much digestible food out of the corn stalk left to rot in the field as is saved from the crop in ears and pulled fodder.

The simplest way to get the most food out of the corn crop is to cut close to the ground with short-handled hoes at about the time the fodder would be pulled, and cure in a silo. Lacking the silo, cut the corn in the same way a few days later, or about the time fodder is generally pulled, and shock in the field. Put 400 to 600 pounds in a shock, and stand the buts out open enough to make the shock stand firm and let in the air to dry the corn. Bind the tops tight to hold together and keep out rain.

When cured, shuck out the ears, and cut what is left, known as stovers (the stalks, blades and shucks), into inch lengths. Feed to cows or work teams with cotton-seed meal, wheat bran, or such other nitrogenous materials as can be most readily obtained. For nearly balanced ration, feed one pound of meal to four of stover and two of oat straw. The stover alone, fed freely, will support an animal at rest and not giving milk.

The following experiment, conducted during 1893, illustrates forcibly the above statement that there is a serious loss in pulling fodder, and that by cutting the whole corn plant almost twice as much food material may be saved.

One rod of a row of corn was cut close to the ground like the rest of the field. The leaves were carefully pulled and weighed. The ears were broken off and the green husks weighed. The ears and stalks were weighed separately. This was chosen to represent as nearly as possible an average of the part of the field where it grew but fell below an average, as the whole row yielded at the rate of 16.37 tons per acre, while this one rod raised by multiplication to acre-yield was but 13.84 tons. It is, however, better than the average of 10.1 tons per acre for the whole field.

This corn was planted March 31st and grew tall. It was checked by dry hot weather in June and July. This caused the ears to stop growing and they were shorter than they should have been. The corn was from thick milk stage to nearly ripe but not dried. The dry weather had caused the lower leaves to dry about half way up the stalks. This accounts for the high per cent. of dry matter in the leaves.

The fresh plants were composed of 12.01 per cent. of ears, 7.73 per cent. of husks, 16.28 per cent. of leaves, and 60.53 per cent. of stalks.

The proportion of dry matter of each part was of ears, 43.71 per cent.; of husks, 23.25 per cent; of leaves, 33.52 per cent., and of stalks 23.00 per cent. The total yield of dry matter calculated to one acre was 1,503.88 pounds in ears; 515.59 pounds in husks; 1,565.08 pounds in leaves and 3,990.25 pounds in stalks.

Reducing this dry matter to percentage again shows that the 12 per cent. of the fresh crop in ears contained 19.85 per cent. of the dry matter in the whole. The 7.73 per cent. in husks contained only 6.81 per cent. of the dry matter, while the 16.28 per cent. of leaves contained 20.66 per cent. of the dry matter of the whole crop. In the 60.53 per cent. of stalks was found 52.68 per cent. of the dry matter, which was over half of the entire crop in dry matter. This helps us to understand the reason why ensilage goes so far in cattle feeding. It also contains a very strong reason why farmers should cut up their corn and save the whole plant instead of pulling the fodder and neglecting to save half of what they have grown.

It is notable that the ears and leaves contained but little more than 40 per cent., and with husks or shucks added were less than half the crop of dry matter, which is the part that counts for food.

Again, of the digestible portion, the really valuable part, while higher percentages of digestibility are obtained for the corn and pulled fodder than for the stalks, it has been elsewhere shown that by feeding a cheap by-fodder rich in protein with a coarse product like corn stalks, the digestibility can be largely increased so that by such feeding in a skilful combination of these different articles it is quite possible to get more from the stalks than from the parts usually harvested if fed by themselves.

It has often been remarked by practical farmers in the Northern States that they seem to get as much from their stover (corn stalks and leaves cured together after the ears have ripened) as from timothy hay. This is doubtless true where cotton-seed meal, linseed meal, or pea-meal is fed freely to stock. In order to secure this gain, either of these feeds alone, or mixed with wheat bran, may be fed in varying proportions to suit the aim of the feeder. One pound of meal to from four to six of stover will be suitable for the production of milk or suffice for hard work of steers or mules, provided the animals are fed all they will eat up clean in the proportion named. For growing stock one of the meal to six or eight of stover will do, while for maintenance alone, as in work stock at rest, the stover may often support the animal, or from one to two or three pounds per day of the meal may be required according to the age and thrift of the animal.

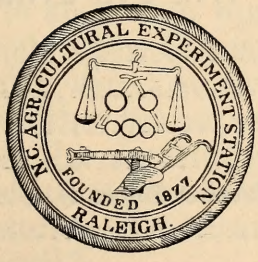
The best way to feed stover is to cut up fine, in half-inch lengths. Some feeders then prefer to moisten and mix the meal with the stover. The cutting may be done with a hand machine for a few animals, or even with a broad-axe for two or three, but some power is better. A good way is for some man in a neighborhood to buy a machine and cut by the day, or ton, for others. This plan is now being practiced in some places to the entire satisfaction of all parties concerned.

The Chestnut and Its Weevil

Nut Culture for North Carolina

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
RALEIGH, N. C.

BULLETIN NO. 105.



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RALEIGH, N. C.

THE CHESTNUT AND ITS WEEVIL.

By GERALD McCARTHY, Entomologist.

When the country comprised within the present State of North Carolina was first settled by white men the chestnut was the most common forest tree all through the west-central and western districts of the State. In the foot-hills of the Blue Ridge mountains these trees were often found of gigantic size. The woodman's axe, casual fires, and the ravages of the root disease have wrought much havoc in these grand forests, but there yet remain sufficient trees to make the gathering of chestnuts one of the principal occupations during the fall months of the people of the western part of the State. Formerly chestnuts were shipped by the car-load to Northern markets from towns along the Western N. C. Railroad, but the business is now greatly curtailed. Of recent years there has been an ever increasing complaint about the wormy condition of the nuts when they reach their destination. Nuts apparently sound when shipped are often found so badly infested by weevils as to be unsalable when the consignment reaches market.

The cultivation of chestnuts in orchards, as apples and other fruits are grown, is as yet scarcely begun in this State. The varieties so far planted in orchards are almost wholly the Mammoth Japanese and Spanish Sweet. The quality of both these species is far below that of the native forest chestnut. These foreign varieties, especially the Japanese, seem to be less damaged by the weevil than the native nut, but they are by no means exempt. In order to learn the present condition of the chestnut interest, a circular was recently sent out from this Station to about one hundred persons within the State, living in neighborhoods where the native chestnut is yet abundant. Copies of this circular were also sent to prominent horticulturists and entomologists in other States, soliciting replies to the following questions concerning the chestnut weevil:

1. How long has the chestnut weevil been known in your locality?
2. Which variety of chestnut—American, Spanish or Japanese—is most attacked by the weevil?
3. What proportion of mature nuts are found wormy?
4. How soon after gathering the nuts do the worms appear?
5. When does the parent beetle appear on the trees?
6. Are worms found in stored nuts in spring time?
7. Can wormy nuts be utilized in any way?
8. What remedies or preventive measures have been tried for the weevil?

Replies to Circular.

Replies were received from nearly all persons addressed. Abstracts of the more important of these are annexed.

Allen Warren & Sons, Greenville, N. C. (Eastern District.)—We have known the weevil ever since we can remember. The Japanese is most attacked. No worms apparent when burr first opens, but they appear in ten to fifteen days. When we gather the nuts we place them on a sieve and plunge it into boiling water for a few seconds. The nuts are then spread out to dry before being packed. This prevents the appearance of worms.

N. W. Craft, Shore, N. C. (Western District.)—I have known the weevil for fifty years. It was as destructive when I was a boy as it is now. Only the native chestnut is grown here. Some seasons the weevil is more abundant and destructive than in others. On an average one-tenth of the crop is ruined by weevils. The weevils are in the nut when it falls and soon after come out. Live worms are rarely found in nuts kept over winter. Know no use for wormy nuts. The nuts are so abundant here that we do not take time to gather them all.

H. P. Kelsey, Linville, N. C. (Western District.)—Have known the weevil in the mountains for fifteen years. The American chestnut is most attacked. From one-eighth to one-half the crop is annually destroyed by the weevil. They begin to issue from the nuts soon after gathering and may continue to come out during the winter. Have often found them in the nuts in spring. Have often seen the nuts scalded in boiling water to destroy the worms. I have seen the female insect ovipositing on the chinquepin, and more rarely on the chestnut. Know of no remedy.

R. L. Patton, Swannanoa, N. C. (Western District.)—Have known the chestnut weevil as long as I can remember, about thirty years. It does more damage now than formerly. I know only the native chestnut, which is abundant here. From one tenth to one fifth of the crop is wormy, when the nuts fall. If left to lie they soon all become wormy. If the nuts are gathered as soon as they fall and dried in the sun it saves most of them.

Calvin J. Cowles, Wilkesboro, N. C. (Western District.)—Have known the weevil for sixty years. It was as common sixty years ago as now. It also infests the chinquepin. Nuts are not wormy when they first fall, but if not sun dried at once will become so in about two weeks. I have noticed the beetle only on the chinquepin. It seems to do its work while the burrs or nuts are young and green. Only dead worms are found in nuts kept over winter. They seem to mature about the time the nut falls. They then cut their way out and bury themselves in the ground. Wormy nuts can be utilized only by feeding them to hogs. The best treatment for chestnuts is as follows: Dip them into boiling salt water long enough to heat but not cook the nuts. Then spread in the sunshine for a few

days. After this let them dry in the shade until thoroughly dry. If it is necessary to ship at once, the sun-dried nuts may be bagged provided all moisture is evaporated from the outside, otherwise they will mildew. The brine keeps the shell soft and pliable and the kernel more palatable than when not thus treated.

P. J. Berckmans, Augusta, Ga.—The native chestnut is not found here. Have cultivated the Spanish and Japanese varieties for years, but never found them attacked by the weevil.

H. Ridgely, Dover, Del.—Have known the chestnut weevil as long as I can remember. The American is most attacked. From thirty to forty per cent. of the crop is wormy. So extensive is the damage that now few dealers will buy chestnuts. The worms appear in about ten days after the nuts are gathered. A remedy is much needed.

Chas. Black, Hightstown, N. J.—The chestnut weevil has been more or less troublesome as long as I can remember. In some seasons they are worse than in others. The Japanese and Spanish were most attacked this year, having fully fifty per cent. weevilly. The weevils make their appearance soon after gathering the nuts, and work for a month or so. The live maggots are never found in spring in dried nuts, but may be found in nuts which have been kept moist, as they must be when intended for seed. The weevilly nuts might be fed to swine, no other use for them. Know of no remedy for this pest.

J. W. Kerr, Denton, Md.—The chestnut weevil has been known here further back than I can remember. The American and Spanish chestnuts are both attacked—the latter probably most. The Japanese nut is nearly exempt. From ten to twenty-five per cent. of crops is annually destroyed. I do not know the reason, but with me it is a rare thing to find a wormy nut among the Japans.

R. C. Hewson, Penn Yan, N. Y.—The chestnut weevil has been known here for a long time. From one-tenth to one-twentieth of the crop of the native nut is annually destroyed by the weevil. The insect resembles the plum curculio and can be defeated by fumigating with creosote or carbolic acid.

L. A. Goodman, Westport, Mo.—The chestnut weevil has never done any damage here. I have about fifty bearing trees of the American variety, about eighteen years old.

T. T. Lyon, South Haven, Mich.—I have known the chestnut weevil in Michigan for sixty years. There are but few indigenous chestnut trees in this State. I have the only bearing orchards of the Japanese and Spanish chestnuts in this vicinity. These have been in bearing for only three or four years and the weevil has not yet discovered them. From five to twenty per cent. of the crop of the native variety is annually destroyed by the weevil. About October 1, 1893, I received four pounds of chinquepins from Tennessee. I found them all infested and the mature larva just coming out. The nuts were burnt.

T. V. Munson, Denison, Texas.—There are no bearing chestnut

orchards in this vicinity. There is, however, a weevil about the size of a pea weevil which infests acorns, hickory nuts and pecans. Live-oak acorns are especially liable to attack. This may be the same beetle which infests chestnuts, but I call it the acorn weevil.

J. Alexander Fulton, Dover, Del.—The chestnut weevil has been very bad here during the last two years. The complaint as regards the Spanish variety is universal. We have few bearing trees of the other varieties. I have a very fine tree, about twenty-five years old, and last year the worms destroyed every nut. The nuts were infested before becoming ripe. The weevil enters at the bottom of the pod or burr, making a round, clear hole. I am glad you have taken up this matter, for unless a satisfactory remedy can be found I am certain our chestnuts are doomed—all varieties will share the same fate.

Wm. P. Corsa, Washington, D. C.—From personal recollection and family history I know that the chestnut weevil has been a pest in the neighborhood of New York city for over ninety years. In Virginia, the chinquepin is more attacked than any other variety of chestnut. I once saw, near Fulton, Delaware, upon just-opening burrs of the chinquepin, large numbers of the beetle, but was unable to determine whether or not they were ovipositing. The date was about September 1. The most successful remedy is to scald the nuts as soon as gathered and then dry well in the sun before storing them. To scald, place a bushel or so of nuts into a wash-tub and pour in enough boiling water to come one or two inches above the nuts. Stir vigorously with a stick and the weevilly nuts will come to the surface; skim these off and destroy them. About five minutes in the water will be sufficient. Scoop the nuts out with the hands and place them in sacks, about half-filled, in the sun. Shake and manipulate freely to hasten drying. The kernels of nuts thus treated remain soft and tender all winter, and do not get flinty as those not treated do. Of course nuts intended for planting must not be treated in this way.

The Chestnut Weevil, *Balaninus proboscoideus*, Fab.

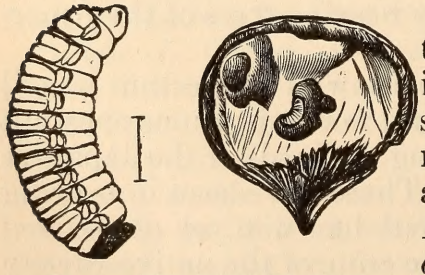


Fig. 1.—Chestnut Weevil.

The chestnut weevil is a member of the curculio tribe of the beetle family of insects. The genus *Balaninus* includes seven American species, all of which are nut weevils, viz.: *B. proboscoideus*, which attacks chestnuts and chinquepins only; *B. rectus*, chestnuts and acorns; *B. quercus*, acorns only; *B. nasicus*, acorns only; *B. carya*, hickory and pecan nuts only; *B. uniformus*, acorns only; *B. obtusus*, hazel nuts only. All of these species are more or less common throughout the Atlantic, Gulf and Middle States, or wherever their food plants are indigenous. *B. proboscoideus*, *B. quercus* and *B. carya* are most abundant in the South

Atlantic region. All the species of *Balininus* are much alike, and are characterized by the extreme length and slenderness of the beak or snout. In the male beetle the snout is about the length of the body; in the female it is twice as long as the body. The snout is used to pierce through the thick and immature husk or burr of the nut and gouge out a place for depositing the egg. As the husks of this class of nuts are very thick the beak must be proportionately long. The chestnut weevil is yellowish, with rusty spots and lines on the wing covers. It is about the size of the common pea weevil. The footless grub is white or cream-colored, with a red or yellowish head, about half an inch long when full grown, nearly cylindrical.

The winged beetles appear on the chestnut trees about the time these begin to bloom or a little after. The female lays her eggs, as already mentioned, by piercing the young ovary or husk and deposits from one to four eggs in each. The eggs hatch in a few days. The shell of the nut subsequently forms and hardens around the grub. The hole seen in the shells of mature nuts are always made by an escaping grub, never by one entering. The number of eggs laid by each female is not known, but is probably not less than fifty nor more than one hundred. As soon as the eggs are laid the winged insect dies and no more are seen until the next spring, there being but one brood each year. In the latitude of North Carolina and further south the grub reaches maturity soon after the nuts are ripe and the burr opens. Under ordinary circumstances the grub escapes from the nut within ten days after the burr falls from the tree. It then enters the ground and changes to the *pupa* state, in which it remains dormant during the winter. In spring it issues as a winged beetle to produce eggs for the next brood of grubs, and so on from year to year. In this latitude no live worms are found in stored nuts after Christmas, unless these nuts have been artificially kept cool so as to keep the worm in a sort of torpor. Further north it is possible the worms remain alive in the nut during winter, escaping in the spring. This is more apt to happen when cold weather comes early, by which the worms are benumbed before reaching maturity. The worm will very likely remain in the ground as a dormant pupa during the succeeding summer, coming forth as beetles the following year. This will account for the fact that one year the nuts are generally destroyed by the worms and the next year but few are damaged.

Remedies.

As regards the native or forest chestnut under ordinary circumstances there is no practicable treatment except to sort out the sound nuts from those ruined by the worms as shown by the holes in the shells. Some of our correspondents have advised that the nuts be thrown into water, hot or cold, and those that float be skimmed off and thrown away. Hand picking as far as possible should follow

this plan. In this way wormy nuts can to a great extent be thrown aside, and only the whole ones be shipped. A very convenient plan is that described on p. 270 by Wm. P. Corsa, of Washington, D. C. To prevent the escape of the worms into the ground, the nuts should be gathered as soon as they fall and stored in tight boxes or bins from which the worms cannot escape. After twelve or fifteen days they may be killed by fumigating the bin or box with carbon bisulphide. Use eight ounces of this to a ton of nuts and cover the box or bin tightly for twenty-four hours. Then expose to the air until the carbon bisulphide has all evaporated. It will not hurt the edible nuts at all. It must be remembered that the worms do not pass from nut to nut but always remain in the nut upon which the egg was originally laid. If *all* the nuts were gathered as soon as they fall and subjected to this treatment or the scalding process described by several of our correspondents, the brood of beetles for the next year would be greatly reduced if not practically exterminated. It is, however, certain that a portion of the grubs which enter the ground in the fall may remain therein during the whole of the succeeding year—coming forth the second year, hence this treatment should continue for two sucessive seasons. But under our present unsystematic management of forest lands no such thorough treatment is practicable. It is likely then that the damages of the chestnut weevil will continue until the wild native nuts are wholly excluded from the market except as to nuts sorted over by hand as already advised. A brand of nuts known to be hand-sorted will always sell. There are one or more natural parasites of this insect, but these parasites do not seem to reduce the numbers of the pest, though undoubtedly they greatly moderate its noxious activity. Real and trustworthy preventive measures become possible only when chestnut trees are grown in orchards and given the necessary care given to other valuable fruits. Where such a course is pursued the insect can be as easily controlled as its near relative, the plum curculio, and by much the same means. The use of London purple or Paris green—one pound to two hundred gallons of water—will be found very useful if applied after the trees have passed out of full bloom or a little later. The spray must be directed especially towards the flowers and young fruit. Jarring the trees during the blooming period as is now done for the plum curculio will prove as beneficial in this case as for the plum. The nuts as soon as the burr opens should be gathered and scalded as recommended. When these measures are carefully and thoroughly carried out, there will be little damage from the weevil. To make the treatment easy and therefore more practicable only dwarf growing varieties or trees should be planted in chestnut orchards. Where edible nuts other than the chestnut are attacked by weevils substantially the same treatment advised for the chestnut will be found satisfactory, as all these weevils are closely related and for practical purposes may be regarded as identical.

APPENDIX.

[NOTE: In order to make the recommendations, given in this bulletin, for combatting nut weevils more practical, the following excellent paper on orchard culture of nuts is reprinted from the 13th Annual Report of the N. C. Horticultural Society.]

NUT CULTURE FOR NORTH CAROLINA.

BY W. A. TAYLOR, ASSISTANT POMOLOGIST, U. S. DEPARTMENT OF AGRICULTURE.

The subject of nut culture is a new one to most American fruit-growers. Until recently our almost boundless forests, rich in nut-bearing species, have yielded a supply sufficient for the demands of our markets. The river bottoms of Louisiana and Texas have yielded their tribute of pecans; the valleys of more northern States have supplied an abundance of black walnuts and butternuts; the forests of Appalachian ridges have furnished toothsome chestnuts, which have found sale at prices usually profitable to the collector. While the shagbarks of New England and the Central States have long been staple commodities in city markets, none of these have been planted or cultivated for their nuts until recently, because of the belief that their culture could not be made profitable.

But the progress of our impetuous civilization has gradually worked a change in forest conditions. The axe has given way to the saw-mill, and the fire from the burning log-heap has not ceased its destruction at the line-fence of the settler. Our forest area is rapidly diminishing, and the area of nut-bearing trees decreases at even a faster rate because of the greater value of the timber of most nut-bearing species. The near future is sure to witness a change in the source of the supply of nuts now demanded by our city markets similar to that which has been witnessed in regard to our small fruits, *i. e.*, the wild nuts will be replaced by the larger, finer and in every way superior products of cultivated plantations.

From the fact that choice nuts can be shipped for long distances, it is probable that the nut culture of the future will become localized, both as regards species and varieties. Certain localities will be found to produce a superior product of the pecan, the walnut, the chestnut, the hazel and the shell-bark, and the production of those particular types will become specialties in those localities. This tendency is already strongly marked in California, where, after a quarter of a century of somewhat indiscriminate planting, it has been found that the Persian walnut (*Juglans regia*) and the almond cannot be profitably grown in the same climates, but succeed admirably in regions not widely separated.

It is therefore of the utmost importance that planters study their conditions and select species suitable to their localities before embarking in nut culture on an extensive scale. As in all fruit culture, only careful experiment can settle uncertain points. It is with a view to encourage and aid in directing such experiments that the following suggestions are offered to North Carolina nut planters:

Of the many nuts found on our markets, not all are worthy of attention of the cultivator at the present time.

The black walnut, butternut, mockernut (*Hicoria tomentosa*) and the big shell-bark (*Hicoria sulcata*), though of some value, are not worth planting for their nut product. Our native chestnut, as commonly found, may be included in the same list, though a few choice varieties are worth a trial.

The nuts which are believed to be worth planting in North Carolina for market are the pecan, the Japanese and European chestnuts, and perhaps the Persian walnut.

Chestnuts.

Because of their large size, the Spanish and Japanese chestnuts find ready sale in our markets at good prices. Neither of them is equal to our native chestnut in flavor, but considerable quantities are imported and sold by roasters from stands on our city streets. They sell for about twice as much as our native varieties. Of the two species the Spanish is of better quality than the Japanese, though the latter is the larger nut and the tree comes sooner into bearing. Both can be quite easily grafted on the American chestnut, either by cleft grafting at the crown or by whip grafting the top or branches. They will probably succeed wherever the native chestnut thrives, and are therefore suited to the higher portions of the State, including the ridges of the piedmont and mountain regions. For the present their planting should be confined to experimental plots, as it is highly probable that American varieties of these species will soon be developed which will supersede them in our markets. Two such have already come to notice, both of the Spanish type—the Paragon and Ridgely. The Paragon originated in Germantown, Philadelphia, and is a large nut of good quality. The Ridgely, of which the original tree stands near Dover, Delaware, is a little smaller, but is reported to be very productive and of good quality. A variety that will yield nuts as large as the Paragon, and equal to our native chestnut in quality, is the *desideratum* of our nut-growers now. The originator or discoverer of such a tree has both honor and financial recompense awaiting him.

Of the imported European varieties Numbo has proved most valuable thus far, enduring the winters and yielding good crops of large nuts in eastern Pennsylvania. The best Japanese varieties yet tested are the Giant, Early Prolific and Superb—all large nuts.

Pecan.

This tree, which is native to the river bottoms of the lower Mississippi valley, Texas and Mexico, is our most promising indigenous species. It occurs as far north as Davenport, Iowa, and the tree grows to a large size in the valley of the Wabash. Occasionally planted trees have endured the winters and borne some nuts as far north as Philadelphia, but there is little probability that large thin-shelled pecans can be produced north of central Virginia. In North Carolina it will probably succeed best at elevations less than five hundred feet above sea-level. The tree requires rich soil and prefers moist alluvial ground that is rarely flooded. It will grow well on dry soil if rich and not too porous. The trees should be planted to stand not closer than thirty-five or forty feet apart each way. Unless the little trees can be carefully looked after, it will be found better to start the seedlings in nursery and transplant at one year, than to plant where the trees are to stand, particularly if seedlings are to be depended upon without budding or grafting. These latter operations are less successful with the pecan than with most fruit trees, though they are by no means impossible to accomplish. On seedlings one or two years old annular budding in early summer succeeds best. On trees of larger size, two inches or more in diameter, cleft grafting at the crown, before the buds start in early spring, banking the scions to the top bud with earth, has been found successful. Only such pruning as will keep the trees well balanced is needed. The growth of cultivated crops among the trees will be found advantageous if the fertility is kept up. Only the choicest nuts should be planted, unless for grafting, and seed nuts should be secured from regions where climatic conditions are as nearly identical with the locality as possible. For North Carolina the best varieties will probably be found in South Carolina, Florida, Mississippi and Louisiana. Among them may be named the following:

Faust, a South Carolina variety of medium to large size, medium shell and good quality.

Frotscher, a Louisiana variety of large size, very thin shell and plump kernel of good quality.

Jewett, from Mississippi; a large long nut, rather irregular; shell medium; quality very good.

Ribera, a large variety from Florida.

Stuart, a large, roundish, oblong nut from Mississippi.

Turkey Egg, a variety from Florida; large and thin-shelled.

Van Deman, a large variety from Mississippi, of oblong form and thin shell.

Persian Walnut.

This species (*Juglans regia*), which is quite commonly known under the names English walnut and Madeira nut, has long been experimentally planted in our Eastern States. Occasional trees about the

older cities of the Eastern States succeed so well that there is encouragement for further effort with the improved varieties known to be of superior hardness and productiveness. It should be thoroughly tested in those portions of North Carolina where the combination of good soil, mild climate and freedom from late and early frosts is found—notably in the thermal belts of the southwest portion of the State. In California this nut is largely grown from seed, though it is easily budded and grafted upon seedlings of its own species and upon the native California walnut. It could probably be successfully worked by annular budding on small trees of the black walnut just as the sap is starting in the spring. The varieties which have proved hardiest and most productive thus far are of comparatively recent introduction from France. They are the Chaberte, Franquette, Mayette and Præparturiens, the last named being the best known and most widely disseminated of the type. It is a nut of but medium size, but so precocious and regularly productive as to make up in quantity what the individual nuts lack in size. A few trees of each of these should be planted in every locality where conditions are favorable. It is probable that at least one of the Japanese walnuts (*Juglans sieboldiana*) recently introduced will be found suited to conditions where the Persian walnut succeeds, but it has not as yet been fruited in the eastern United States.

Rational Stock Feeding

INCLUDING

I. DEFINITION OF TERMS, AND COMPOSITION AND DIGESTIBILITY OF FOODS.
II. FEEDING STANDARDS.
III. HOW STOCK RATIONS CAN BE CALCULATED.
IV. SOME RATIONS FED IN NORTH CAROLINA AND SOME RATIONS SUGGESTED.
V. COMMENTS OF PRACTICAL STOCK BREEDERS AND FEEDERS.

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
RALEIGH, N. C.

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N. C. COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

THE NORTH CAROLINA

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INCLUDING

THE FERTILIZER CONTROL STATION

AND THE STATE WEATHER SERVICE,

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RALEIGH, N. C.

PREFACE.

The subject of stock feeding is of such importance that the Experiment Station continues to call attention to it, not only in conducting experiments to determine the digestibility of various common foods in daily use, but also in distributing information designed to be of immediate value to the stock feeder.

There are in North Carolina, according to the latest returns (State Auditor's Report of 1893),

Horses	143,157,	valued at	$7,499,873.
Mules	108,926,	"	6,496,298.
Cattle	634,754,	"	4,954,339.
Hogs	1,118,743,	"	1,498,437.
Sheep and Goats	404,996,	"	401,113.
Total	2,410,576,	"	$20,850,059.

Assuming that the very small sum of fifteen cents per month for each head could be saved by more careful feeding, there would be saved to the people of the State over four millions of dollars annually, a sum approximating nearly one-sixtieth of the total assessed real and personal property of the whole State.

All stock feeds are not the same in quality; some are richer in some ingredients than others. These ingredients when eaten in food act differently in building up the body. Some make flesh, some make bone, some make heat and force. Foods, therefore, vary greatly in value for different purposes. Again, the constituents may not wholly be available to the animal. A portion of a certain constituent may be easily digested, while the other part may pass entirely through and go off as waste. If the manure is not preserved it is really an absolute waste. The digestible portions of the various constituents must be determined by actual feeding tests with animals, while the constituents must be carefully analyzed chemically. By actual feeding it has been ascertained what quantity of these digestible constituents is needed for different purposes of feeding to produce fat, or growth, or sustain vigor when worked. In this way we can lay down a rule for feeding animals, and knowing the foods we have at hand and the digestible proportions, it will be easy to combine them according to the best advantage.

The object of this bulletin is to describe in detail the methods for studying the various foods at hand and ascertain what combinations are best for certain purposes. The importance of the subject is such that a portion of bulletin No. 90 of this Station by B. W. Kilgore, Assistant Chemist, is reprinted in order to present herewith a more complete presentation of the various points bearing upon the subject.

The people of the State in order to make money must save it, and to accomplish this no better way can be suggested for immediate trial than more careful feeding of their stock. To this end a thorough understanding of the principles underlying it is essential. Our people must weigh their stock foods, and mix them in the right proportions if they desire to stop a tremendous leak in farm economy.

H. B. Battle, *Director.*

RATIONAL STOCK FEEDING,

INCLUDING

I. DEFINITIONS OF TERMS, AND COMPOSITION AND DIGESTIBILITY OF FOODS.
II. FEEDING STANDARDS.
III. HOW STOCK RATIONS CAN BE CALCULATED.
IV. SOME RATIONS FED IN NORTH CAROLINA AND SOME RATIONS SUGGESTED.
V. COMMENTS OF PRACTICAL STOCK BREEDERS AND FEEDERS.

By F. E. EMERY, Agriculturist, and B. W. KILGORE, Assistant Chemist.

I. DEFINITIONS OF TERMS, AND COMPOSITION AND DIGESTIBILITY OF FOODS.

The value of food materials depends largely upon their composition and digestibility. The former is ascertained by chemical analysis; the latter by actual trials with animals.

Composition of Feeding Stuffs. Nutrients.

By chemical analysis, foods are separated into six classes of substances, viz.:

1. *Water*, which is present in all feeding stuffs. It composes about 80 per cent. of green and succulent fodders, about 90 per cent. of root crops, 75 per cent. of silage, and 10 to 15 per cent. of hays and grains. In these it is present as mechanically adhering or hydroscopic moisture. It is a necessary constituent of the animal body, of which it makes up 40 to 65 per cent. Water is determined by heating the substance for several hours at the temperature of boiling water, at which temperature it passes off as steam.

2. *Ash* is the inorganic, or mineral matter of plants, and is the residue left after burning till all volatile material is driven off. It is composed mainly of soda, potash, lime, and magnesia, in the form of phosphates, sulfates, chlorids, and carbonates. Ash furnishes the materials for the bony structure of animals, and enters to a much less extent into the tissues and organs.

3. *Fats* (*ether extract*) represents whatever is dissolved from foods by dry ether. It is composed mainly of fats and oils, but contains, in addition, quantities of gums, wax and coloring matter, depending upon the substances extracted.

4. *Protein*, the term as used in connection with fodder analyses, includes *Albuminoids* and *Amides*, the albuminoids being the more

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Note.—Parts 1, 2, and 3 are reprints from Bulletin 90, with changes and additions.

valuable, and, at the same time, composing by far the larger portion of the protein compounds. They are the nitrogenous compounds of plants and animals, and are determined by estimating the nitrogen in them, which element composes about 16 per cent. of the weight of protein substances. None of the other classes of substances contain nitrogen. They are represented in the animal body by ligaments, lean meat, muscles, tendons, and tissues. *Amides* are unorganized protein, or protein in a transitory stage, and are very abundant in pasture grass and young growing plants, but change largely into organized protein as the plant reaches maturity. Amides are considered of much less nutritive value than albuminoids, and act as protectors or conservers of the latter.

5. *Crude fiber*, or *cellulose*, is the cell wall and structure material of plants, and is usually the most indigestible portion of them, but when digested is considered of equal value to starch and sugar. The lint of cotton is almost pure cellulose. Its composition is similar to that of starch. It is determined by boiling the food-stuff with weak acid and alkali, thus dissolving all other constituents. *Crude fiber* and *nitrogen-free extract* taken together are known as *carbohydrates.*

6. *Nitrogen-free extract* is the term applied to those non-nitrogenous constituents of foods which are represented in the main by sugars, starch, dextrin, and gums. They all contain carbon, hydrogen, and oxygen, but no nitrogen, as does protein. Nitrogen-free extract is estimated by difference, it being equal to the difference between the sum of the above five constituents, water, ash, protein, fats, and crude fiber, and 100. It is, perhaps, the most inaccurate of all the determinations in a food analysis, inasmuch as all the errors and differences in the other determinations fall upon it. It seems very desirable that some of the constituents, at least, of the nitrogen-free extract should be determined directly. This is already being done to a limited extent. Some preliminary work has been done in this laboratory in that line, and the study will be carried on.

Dry matter and Organic matter. Neither of these terms represent a single class of constituents, or nutrients. Dry matter is what is left of a plant, or food-stuff, after the water is driven off or subtracted, and organic matter is dry matter minus the ash, for example: if the original food-stuff as fed is represented as 100 per cent., and it contains 10 per cent. of water and 5 per cent. of ash, then dry matter is equal to 100 per cent., less 10 per cent. water, or 90 per cent., and organic matter is 90 per cent. dry matter less 5 per cent. ash, or 85 per cent.

To enable those not familiar with the subject to gain a clear idea of the parts of a food-stuffs, and the terms representing them as used in fodder analyses, the following statement is presented:

Food-stuff. { Water. / Dry matter. { Ash. / Organic matter. { Protein. / Fats. / Carbohydrates. { Nitrogen-free ex't. / Crude fiber.

Nutrients. Protein, fats, carbohydrates, nitrogen-free extract and crude fiber and mineral matter are called nutrients, because of their functions in animal nutrition. Nitrogen-free extract and crude fiber are included together under the one name of carbohydrates, because they are all compounds of carbon, hydrogen, and oxygen, and the digestible portion of each is considered of equal value and perform the same offices in animal nutrition. Familiar examples of the four classes of nutrients are presented below. Water is omitted because it is the same, whether taken in food or drink, and we do not feed a fodder for the sake of the water it contains:

Protein.	Albumen (white of egg), washed lean meat, casein, or curd of milk, gluten of flour, fibrin of blood, gelatin, glue, etc.
Fats.	Cotton-seed oil, linseed oil, olive oil, corn oil, wheat oil, oat oil; the fat of milk (butter), the fat of meat (hog lard), mutton (mutton suet), beef (tallow), fish oil, etc.
Carbohydrates.	Sugars (cane sugar, milk sugar, and glucose), starch, dextrin, gums, woody fiber, etc.
Mineral matter.	Sodium chlorid (common salt), phosphates of lime and soda, etc.

Functions of Nutrients.

Having defined the classes of nutrients as they occur in foods, it is of interest now to state the offices performed by them in animal nutrition.

Water is not a nutrient in the sense in which the term is here used, though the animal body cannot be supported without it.

The ash, or mineral matter, furnishes the material for the bony structure of the body, and, to a far less extent, of the soft tissues. Most of our foods and rations contain an abundant supply of the mineral elements, so little or no notice need be taken of them in feeding.

Protein differs from all the other nutrients in containing the element nitrogen, and is the producer of flesh, ligaments, muscles, tendons, sinews, hair, hide, and all portions of the animal machine which has strength, except the bones. The protein bodies are of the utmost importance in the animal structure. They compose the larger part of the animal machinery, and are the exclusive source of its repair as occasioned by the continuous wear and tear of the system, due to the internal and external movements of the body; they are the basis of blood, and the source of casein in milk; and in the absence of sufficient quantities of fats and carbohydrates in the food for the production of heat and energy, they are transformed into fats, and perform the office of fats in nutrition. This latter transformation may also result from an excess of protein. The heat-producing power of protein is but little different from that of

carbohydrates; the amount of fat it produces is probably much less, while as a heat-producer, fat is worth about 2.25 times as much as protein. These facts, combined with the high cost of protein in foods, renders it usually uneconomical to feed protein for the production of fat to be either stored in the body as such, or to be used as fuel, since the fats and and carbohydrates perform these offices, and cost much less. It is to be remembered that the protein bodies are the "flesh formers," and though they can perform the offices of fats and carbohydrates in nutrition, fats and carbohydrates cannot take the place of protein.

Fats and carbohydrates perform the same offices in the body—those of the production of heat to keep the body warm, and the force by which the animal mechanism is run. They are the "heat and force producers," and are consumed in the body as fuel, giving out heat, muscular, and intellectual energy. For the production of heat and energy one pound of fat is worth about 2.25 times as much as a pound of carbohydrates. Fats give out about 2.25 times the heat that carbohydrates do. Besides serving as heat and force producers, carbohydrates are converted in the animal body into fats, and, together with the fats of the food, are stored as such in fatty tissue. The value of carbohydrates for the production of fats is supposed to be in about the same proportion as the heat-producing powers of carbohydrates to fats.

Carbohydrates are not found in the animal body as such, but are converted into fats. There are, therefore, only four classes of substances composing the animal body, viz.: water, ash, fats, and protein.

The main and distinctive offices of the nutrients of foods are: Ash, or mineral constituents, are bone-producers; the protein bodies are the flesh-formers; and fats and carbohydrates are the heat and force producers. The nutrients already located in the animal body perform the same offices as the corresponding ones of foods. In case of a deficiency of nutrients in foods given, the fats, or protein and fats, are drawn upon to assist in running the animal machine. Carbohydrates and fats, in being consumed, prevent the consumption of protein, but so soon as they become insufficient to supply the necessary heat and force for the body, protein substances, in the form of lean meat, muscle, etc., are drawn upon. A sufficient supply of carbohydrates and fats is, therefore, necessary to the protection of the animal frame-work. The following is a statement of the

Functions of Food in the Animal Body.

Food nourishes and supports the body

By supplying—

1. The materials of which it is made.
2. The materials to repair its waste and wear.

By producing—

3. Heat to keep it warm.
4. Force and energy for muscular and other work.

These offices are performed by the nutrients:

Protein -----	Which is the basis of blood, lean meat, tendons, ligaments, sinews, hair, skin, etc.—
	Is converted into fats.
	Is used as fuel for heat and force.
Fats -----	Are used as fuel for heat and force.
	Are stored in the fatty tissue of the body.
Carbohydrates (Nitrogen-free extract and crude fiber).	Are converted into fats and stored in the body, or
	Are used as fuel for heat and force.
Mineral matter	Forms bone and a very small part of muscular and fatty tissues.

The Digestibility of Feeding Stuffs

As was stated in the beginning the value of feeding stuffs depends upon their composition and digestibility. The element of composition has been discussed; next will be considered the digestibility.

All the food eaten by an animal is not digested and used in nutrition, but only that portion which is dissolved by the alimentary agents and taken into the circulation of the system, the portion which is assimilated. The residue, or undigested portion, forms the solid excrement of the animal.

The digestibility of a considerable number of American cattle foods have already been determined. This is done by feeding a uniform and weighed quantity of food of known composition for sufficient length of time to eliminate all residues of previously fed fodders, then collecting the dung for a number of days, usually five or six, weigh and analyze. The dung contains the undigested food residue, and the difference between this and the total food consumed gives the portion digested. Thus, two foods having the same composition, their values would be determined by the amounts of nutrients digested from each.

Average Composition and Digestible Nutrients in Feeding Stuffs.

In table I is presented the composition, most of them averages of quite a number of analyses, of American feeding stuffs of most interest in North Carolina. The composition, especially of coarse fodders, is affected by so many conditions, as soil, climate, season, cultivation, harvesting, handling, stage of maturity, etc., that the greater the number of good analyses entering into an average the nearer may the average be expected to represent the general composition.

The analyses of the feeding stuffs shown in the table represent their composition as they are usually fed to animals. In addition

TABLE I.—SHOWING AVERAGE COMPOSITION OF FEEDING STUFFS—AMERICAN ANALYSES.

FOODS.	No. of analyses.	PERCENTAGE COMPOSITION.							PERCENTAGE OF DIGESTIBLE MATTER.					
		Water.	Dry matter.	Total protein.	Fats (Eth. extract.)	N.-free ex't.	Crude fiber.	Ash.	Dry matter.	Protein.	Fats.	N.-free ex't.	Crude fiber.	Ash.
Cowpea-vine hay	13	11.90	88.10	14.43	2.49	41.22	21.54	8.42	52.15	9.31	1.24	29.14	9.24	3.79
Crimson clover hay	2	10.85	89.15	15.20	1.84	38.91	25.65	7.73	55.45	10.50	.89	28.82	12.49	4.14
Lucerne, or Alfalfa hay	3	11.53	88.47	14 89	2.24	34.18	30.26	6.90	52.55	10.85	1.15	23.21	13.95	.....
Red clover hay	35	11.63	88.37	12 50	2.43	40.43	26 81	6.15	45.69	6.17	1 03	23.28	12.73	.....
Alsike clover hay	6	8.91	91.09	13.18	2.56	40.48	27 22	7.63	50.00	7.31	1.36	25 95	12.57	.....
Soy (soja) bean silage	1	74.20	25 80	4.05	2.23	6.95	9.70	2 84	15.22	3.07	1.60	3.61	5 31	1.61
Soy bean hay	3	12.04	87.96	15.98	4.19	34 39	27.57	5.83	54 89	11.27	1.74	25.93	16.38	1.38
Peanut-vine hay	2	8 34	91.66	10.31	4.52	46 64	23.14	7.05	54.90	6.53	2.98	32.41	12.01	1.44
Corn silage, whole plant	3	71.98	28 02	2.11	.61	16.42	7.72	1.16	14 91	.73	.40	9.93	3.34	0.30
Pulled fodder, blades alone	2	8 94	91.06	11.82	3.31	41 45	24.72	9.72	54.64	5.34	1.96	26.28	17.06	2.56
Corn fodder, whole plant	11	32.19	67.81	4 81	1.28	37.15	20.21	4 32	.....	2.60	.90	23.63	13.84	.....
Corn stover, whole plant, minus ears	10	22.81	77.19	5.47	1.34	39.90	25.55	4.92	47.70	2 80	.69	25.29	17.04	2.18
Corn butts or stubble, portion below ears*	1	46.74	53.26	1.76	1.08	27.37	20.46	2.59	35.42	.37	.86	18.89	15.04	.30
Corn husks or shucks*	1	8.10	91.90	3.33	0.85	51 55	32.81	3.36	66 17	.98	.28	38.65	26.08	.54
Corn tops, cut above ears	2	12.19	87.81	7.96	2.44	42 16	28.03	7.22	50.32	3.08	1.62	24.37	19.87	.54
Sorghum fodder, leaves alone	1	12.43	87.57	9.60	4.55	44.93	23.93	4.56	55.25	5.84	2.12	28.98	16.84	1.34
Sorghum bagasse	2	11.25	88 75	3.44	1.44	50.47	30.52	2.88	53.78	.47	.67	32.72	19.46	.38
Timothy hay	58	10 21	89.79	6.18	2.19	46 91	30.29	4.22	51.90	3 03	1.21	30.16	16.14	1.46
Red top hay (Agrostis vulgaris)	4	9.52	90.48	7.70	2.14	46.19	28.52	5 93	52.12	4.65	.94	27.30	17.45	1.44
Orchard grass hay	6	9 80	90.20	6.82	2.38	42.12	33.23	5 63	51.68	4.08	1.29	23.42	20.40	1.95
Johnson grass hay	3	12.30	87 70	7 55	2.93	41.62	29.69	5.91	47.80	3.37	1.16	22.64	17.16	3.32
Cattail, or pearl millet	2	10.47	89.53	9.94	1.97	36.62	30.78	10.22	55.78	6.22	.91	21.64	20.47	6.99
Mixed hays	10	15.41	84 59	6.25	2.09	40.30	31.21	4.73	45.93	2.99	1.04	22.93	14.95	.....
Meadow (mixed) hay (horse)	Same composition as above								40.11	3.60	.37	23.42	12.18	.....

*Analyses from Bulletin 20, Maryland Experiment Station.

TABLE I.—SHOWING AVERAGE COMPOSITION OF FEEDING STUFFS—AMERICAN ANALYSES.—*Continued.*

FOODS.	No. of analyses.	PERCENTAGE COMPOSITION.							PERCENTAGE OF DIGESTIBLE MATTER.					
		Water.	Dry matter.	Total protein.	Fats (Eth. extract.)	N.-free ex't.	Crude fiber.	Ash.	Dry matter.	Protein.	Fats.	N.-free ex't.	Crude fiber.	Ash.
Oat straw	13	8.84	91.16	3.80	2.29	39.12	41.23	4 72	45.85	?	.88	20.81	23.75	.....
Whole raw cotton-seed	1	17.51	82.49	14.48	19.38	25.41	20.30	2.90	54.53	9.83	16.88	12.60	15.32	1.25
Whole roasted cotton-seed	1	9.32	90.68	16.09	22.48	25.78	24.03	2.26	50 69	7.56	16.11	13.25	15.84	.....
Cotton-seed meal	4	7.74	92.26	38.78	10.25	30 20	6.37	6.66	67.63	34.05	9.19	18.57	2.96	2.10
Cotton-seed hulls	5	11.50	88.50	4 15	2.92	39.14	39.87	2.38	36.37	.24	2.32	13.42	18.90	.51
Wheat bran	70	12.43	87.57	15 37	3.85	53.44	9.32	5.60	51.92	11.97	2.82	35.16	1.68	.....
Corn meal (cows)	63	15.61	84.39	9.12	3.93	67.92	1.99	1.45	71.39	5.32	3.61	59.16	0	.....
Corn meal (pigs)	Same composition as for cows.								75.53	7.85	3.21	63.98	.58	.....
Corn (digested by horse)	Same composition as for cows.								78.01	8.09	3.32	64 30	0.84	.....
Corn meal (digested by goats)	Same composition as for cows.								71.39	5.32	3.61	59.16	.....	.....
Whole corn (pigs)	201	10.52	89.48	10 59	5.44	69.81	2.09	1.55	77.04	8.40	3.62	63.74	.91	.....
Corn and cob meal (goats)	9	14.52	85.48	8.36	3.51	65.03	7.06	1.52	67.27	5 45	2.97	55.67	3.37	.....
Corn and cob meal (pigs)	Same composition as for goats.								64.62	6.33	2.88	54.37	2.01	.....
Oats‡	25	10.94	89.06	11.38	4.81	60.05	9.85	2.97	.....	8.76	3.94	44.44	1.67	.....
Oats (horse)	Same composition								59.71	9.05	3.42	45 08	2.87	.....
Rice bran, or danse (sheep)	5	9.65	90.35	12.07	8.76	50.04	9.51	9.97	80.63	9.33	7.82	50.04	6.39	.....
Cowpea a bean, ground (horse)	5	14.81	85.19	20.75	1.44	55.72	4 06	3.22	74.16	17.82	0.19	52.13	2.66	.....
Cowpea, a bean, ground (ruminants)	Same composition as for horse.								75.72	18.27	1.17	51.09	2.91	.....
Cowpea, ground (swine)	Same composition as for horse.								77.48	18.28	.70	53 86	2.77	.....
Soy beans (sheep)	8	10.80	89.20	33.98	16 85	28.89	4.79	4.69	75 86	29.64	15.88	17.96	.....	.....
Rye bran (swine)	12	11.64	88.36	14.74	2.81	63.74	3.48	3.59	59.20	9.72	1.61	47.47	.31	.....
Rice (swine)	10	12.44	87.56	7.44	0.19	79.20	0.35	0.38	86 07	6.38	.13	78.88	.....	.....
Potatoes (swine)	12	78.89	21.71	2.14	0.10	17.36	0.56	0.95	19.62	1.55	.....	17.02	.30	.....
Buttermilk	1	91.49	8.51	3.19	0.27	4.49	.....	0.56	8.05	3.05	.25	4.42	.....	.....
Carrots (horse)	15	88.59	11.41	1.14	0.42	7.56	1.27	1.02	9.95	1.13	.....	7.09	.....	.....
Cow's milk, composite (calves)	85.26	14.74	3.21	5.37	5.44	.....	0.72	14.41	3.09	5.36	5.34	.....	.....	

‡Compilation of Dr. E. H. Jenkins, Annual Report Connecticut Experiment Station, 1888.

TABLE II. COEFFICIENTS OF DIGESTIBILITY OF FEEDING STUFFS.

FOODS.	Dry matter.	Total protein.	Fats.	Nitrogen-free extract.	Crude fiber.	Ash.	AUTHORITY.
Cowpea-vine hay	59.2	64.5	50 0	70.7	42.9	45.1	N. C. Expt. Sta., Bulletin 87D.
Crimson clover hay	62.2	69.1	48.8	71.5	48.7	53.6	N. C. Expt. Sta., Bulletin 87D.
Lucerne, or alfalfa hay	59.4	72.9	51.2	67.9	46.1	....	N. Y. State Expt. Sta. and O'Brine.
Red clover hay	51.7	49.4	42.6	57 6	47.5	....	Armsby.
Alsike clover hay	54 9	55.5	53.2	64.1	46.2	....	Maine Expt. Sta., 1886–'87.
Peanut-vine hay	59.9	63.3	65 9	69.5	51.9	20.4	N. C. Expt. Sta., Bulletin 97.
Soy (soja) bean silage	59.0	75.8	71.9	52.0	54.8	56.7	N. C. Expt. Sta., Bulletin 87D.
Soy (soja) bean hay	62.4	70.5	41.6	75.4	59.4	23 7	N. C. Expt. Sta., Bulletin 97 and Sturtevant.
Corn silage, whole plant	53.2	34.4	66 0	60.5	43.2	26.9	N. C. Expt. Sta., Bulletin 87D.
Pulled fodder, blades alone	60.0	45.2	59.2	63 4	69.1	26.2	Maryland Expt. Sta. Bul. 20, and N. C. Sta. Bul. 87D.
Corn fodder, whole plant	....	54.0	70.6	63.6	68.5	....	Sturtevant, Woll, and Penn. Sta.*
Corn stover, whole plant, minus ears	61.8	51.3	51.9	63 4	66.7	44.4	Armsby.
Crushed corn butts or stubble, portion below ear	66.5	21.0	79.5	69.0	73.5	11.5	Maryland Expt. Sta., Bulletin 20, p. 12.
Corn husks, or shucks	72.0	29.5	32.5	75.0	79.5	16.0	Maryland Expt. Sta., Bulletin 20. p. 12.
Corn tops, cut above ears	57.3	38.7	67.3	57.8	70.9	7 5	Texas Sta., Bul. 15, and Maryland Sta., Bul. 20.
Sorghum fodder, leaves alone	63.1	60.8	46.7	64.5	70.4	29.5	N. C. Expt. Sta., Bulletin 97.
Sorghum bagasse	60 6	13.7	46.4	64.8	63.8	13.4	N. C. Expt. Sta , Bulletin 97.
Timothy hay	57.8	49.1	55 5	64.3	53.3	34.6	Maine Expt. Sta., Ann. Rep., 1888–'91, av. 6 determ.
Red-top hay	57.6	60.4	44.2	59.1	61.2	24 3	Maine Expt. Sta., Ann. Rep., 1888 p. 96.
Orchard-grass hay	57.3	59.8	54.6	55.6	61.4	35.0	Me. and N. Y. Expt. Stas., Ann. Reps., 1888, and 8th.
Johnson grass hay	54.5	44.7	39.5	54.4	57.8	56.1	N. C. Expt. Sta., Bulletin 97.
Cat-tail, or pearl millet	62.3	62.6	46.1	59.1	66.5	68.4	N. C. Expt. Sta., Bulletin 97.
Mixed hays	54.3	47.9	50.0	56.9	47.9	....	N. Y. Expt. Sta., and Sturtevant, 8th Ann. Rep., p. 95.
Oat straw	50.3	?	38.3	53.2	57.6	....	Maine Expt. Sta., Ann. Rep , 1886–'87, p. 76.
Whole raw cotton seed	66.1	67 9	87.1	49.6	75.5	43.3	N. C. Expt. Sta., Bulletin 87D.

*Average of Sturtevant, Woll, and Dent fodder, ears glazing; Burrill and Whitman fodder, nubbins glazing; and Burrill and Whitman fodder, by Pennsylvania Station, Annual Report 1890, p. 62.

TABLE II. COEFFICIENTS OF DIGESTIBILITY OF FEEDING STUFFS.—*Continued.*

FOODS.	Dry matter.	Total protein.	Fats.	Nitrogen-free extract.	Crude fiber.	Ash.	AUTHORITY.
Whole roasted cotton seed	55.9	47.0	71.7	51.4	65.9	....	N. C. Expt. Sta., Bulletin 87D.
Cotton-seed meal	73.3	87.8	89.7	61.5	46.4	31.5	N. C. Expt. Sta., Bulletin 97, and Armsby and Wolff.
Cotton-seed hulls	41.1	5.9	79.4	34.3	47.4	21.4	Texas and N. C. Stations.
Wheat bran	59 3	77.9	73.3	65.8	18.0	....	Me. Expt. Sta., Ann. Repts. 1889 and 1891, pp. 61, 39.
Corn meal (cows)	84.6	58 3	91.9	87.1	0	....	N. Y. Expt. Sta., 7th Ann. Rep., p. 279.
Corn meal (goats)	86.9	66.9	80.5	94.2	....	....	N. C. Expt. Sta , Bulletin 97.
Corn meal (pigs)	89.5	86.1	81.7	94.2	29.4	....	Maine Expt. Sta.. Rept. 1885–'86, p. 61.
Whole corn (pigs)	86.1	79.3	66.6	91.3	43 5	....	Maine and Minn. Expt. Stas.. Rept. '85–'6, and Bul. 26.
Corn-and-cob meal (pigs)	75.6	75.7	82 0	83.6	28.5	....	Maine Expt. Sta., Rep. 1885–'86, p. 62.
Corn-and-cob meal (goats)	78 7	65.2	84.6	85.6	47.7	....	N. C. Expt. Sta., Bulletin 97.
Oats	....	77.0	82.0	74.0	17.0	....	German Experiments.
Oats (horse)**	69.36	79.51	71.13	75.08	29.13	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Corn (horse)**	88.72	76.42	61.03	92.11	40.46	....	Ger. Ex , Zusam. u. Verd. der Futtermittel, p. 1216.
Sour milk, clabbered (swine)**	94.6	95.7	95.0	98.5	.....	....	} Zusammen Setzung und Verd. der Futtermittel von
Cow's milk (calves)**	97.88	96.4	99.8	98 2	.....	....	} Dr. Th. Dietrich and Dr. J. König.
Rice bran, or douse (sheep)	89 25	77.33	89.31	100.08	67.29	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1118.
Meadow (mixed) hay (horse)	50.22	57.54	18.00	58.12	39 02	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Field beans, ground (horse)	87.07	85.89	13.20	93.55	65 40	.	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1111.
Field beans (ground) ruminants	88.88	88.05	81.51	91.69	71.89	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1214.
Potatoes, solanum tubers (swine)	92.96	72.54	.....	98.05	55.11	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Pease, ground	90.95	88.10	49.22	96.66	68.39	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Rye bean	67.00	65.96	57.53	74.48	9.01	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1216.
Rice	98.30	85.80	70.10	99.60	.....	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1110.
Soy beans (sheep)	85.05	87.22	94.28	62.18	.....	....	Ger. Ex., Zusam. u. Verd. der Futtermittel, p. 1113.

**Organic substance.

to the chemical composition of the foods obtained by analysis, is presented, also, the percentages of digestible nutrients in each, calculated from the percentage composition of the foods in the table by multiplying by the *coefficients of digestibility* of each food and nutrient contained in table II, which follows.

Coefficients of Digestibility

Are the proportions of the different nutrients digested, and are obtained by dividing the total amount of each nutrient consumed by the amount digested. In Table II are brought together the coefficients of digestibility of all the fodders, the compositions of which are presented in Table I. These are mainly the results of American experiments.

Amount of Digestible Matter in Feeding Stuffs.

In table I is given the average composition of foods, and in table II their digestibility. By combining the data of these two tables the per cents. of digestible matter of the same foods, also shown in table I, are obtained in the following way:

	Cowpea-vine hay contains per cent., or pounds in 100 of (see Table I).		Coefficients of digestibility of cowpea-vine hay (see Table II).		Per cent., or lbs of digestible matter in 100 of cowpea-vine hay.
Dry matter	88.10	×	59.2	=	52.15
Protein	14.43	×	64.5	=	9.31
Fats	2.49	×	50.0	=	1.24
Nitrogen-free extract	41.22	×	70.7	=	29.14
Crude fiber	21.54	×	42.9	=	9.24
Ash	8.42	×	45.1	=	3.79

They may be regarded as representing, as well as per cent., the number of pounds of digestible nutrients in 100 pounds of the various foods in the condition in which they are fed, and are the amounts of these foods used by animals in the support of their bodies.

From this table of percentage of digestible matter in foods, it is easy to ascertain the amounts of digestible nutrients eaten per day by the animals we may be feeding. We only need to multiply the number of pounds of the food or foods eaten by the per cent. of digestible nutrients in them. Say a cow is eating 20 pounds cowpea-vine hay per day, then the amounts of digestible nutrients consumed are found as follows:

	Per cent. of digestible matter in cowpea-vine hay.		No. lbs hay eaten.		Lbs of digestible matter eaten.
Dry matter	52.15	×	20	=	10.43
Protein	9.31	×	20	=	1.86
Fats	1.24	×	20	=	.25
Nitrogen-free extract	29.14	×	20	=	5.82
Crude fiber	9.24	×	20	=	1.85
Ash	3.79	×	20	=	.76

The amount of digestible matter eaten by any animal may be obtained in a similar way. Where two foods are fed in a ration each will have to be operated upon separately, and their sums taken for the total digestible nutrients consumed.

To save the feeder the time and trouble of making these calculations, the amounts of digestible dry matter and nutrients in 1, 2, 3, 4, 5, 10, and 2,000 pounds of the coarse fodders, grains, seeds, and by-products, whose composition and digestibility are presented in tables I and II, have been carefully calculated, and are given in table III. The nitrogen-free extract and crude fiber have been combined in this table under the one name of carbohydrates, because the digestible portion of each is considered of equal value, and they perform the same offices in animal nutrition. The ash is also omitted, for the reason given in the first part of this bulletin. This table must not be supposed to give the absolute amounts of digestible nutrients contained in all the qualities of these various foods, for no two of the same kind are likely to have exactly the same composition, and may differ very widely, nor are any two animals, even of the same kind, likely to possess the same digestive capacity and power of assimilating foods. Even with these unavoidable defects the knowledge thus ascertained can be put to practical use, and, in connection with the Feeding Standards, soon to be described, stock can be fed far more intelligently, safely, and economically.

The digestible nutrients have been calculated for the most convenient numbers only, but by combining these and adding the corresponding nutrients, the amounts of digestible nutrients can be easily obtained for any quantity of food that is likely to be fed under ordinary circumstances. Thus, suppose we desire to know the pounds of nutrients in 15 pounds of any of the foods, we have merely to add the nutrients corresponding to the 10 and 5 pound weights; for 19 add those for 10, 5, and 4, and so on for any number up to 20, which may be obtained by moving the decimal point two places to the left in the line for 2,000 pounds. For numbers larger than 20, multiples may be used, as for 40 take four times the nutrients for 10.

The nutrients in 2,000 pounds of each of the foods were inserted in this table to enable comparison of the digestible nutrients in one ton of the different foods. The chief value of table III will be found in the compounding of rations, and it will receive further consideration under that head.

TABLE III. Showing Amount of Digestible Dry Matter and Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.

Foods.	Weight. Lbs.	Dry matter. Lbs.	Total Protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Cowpea-vine hay	1	.5215	.093	.3838	.0124
	2	1.043	.186	.767	.024
	3	1.564	.279	1.151	.037
	4	2.086	.372	1.535	.049
	5	2.607	.465	1.919	.062
	10	5.215	.931	3.838	.124
	2,000	1,043.00	186.20	767.60	24.80
Crimson clover hay	1	.5545	.1050	.4131	.00898
	2	1.109	.210	.826	.018
	3	1.663	.315	1.239	.027
	4	2.218	.420	1.652	.036
	5	2.772	.525	2.065	.045
	10	5.545	1.050	4.131	.089
	2,000	1,109.00	210 00	826.20	17.96
Lucerne, or alfalfa hay	1	.5254	.1085	.3716	.0115
	2	1.050	.217	.743	.023
	3	1.576	.325	1.114	.034
	4	2.101	.434	1.486	.046
	5	2.627	.542	1.858	.057
	10	5.254	1.085	3.716	.115
	2,000	1,050.80	217.00	743.20	23.00
Red clover hay	1	.4569	.0617	.3602	.0103
	2	.913	.123	.720	.020
	3	1.370	.185	1.080	.030
	4	1.827	.246	1.440	.041
	5	2.284	.308	1.801	.051
	10	4.569	.617	3.602	.103
	2,000	913.80	123.40	720 40	20.60
Alsike clover hay	1	.5000	.073	.3852	.0136
	2	1.000	.146	.770	.027
	3	1.500	.219	1.155	.040
	4	2.000	.292	1.540	.054
	5	2.500	.365	1.926	.068
	10	5.000	.731	3 852	.136
	2,000	1,000.00	146.20	770.40	27.20
Soy (soja) beans (sheep)	1	.7586	.2964	.17964	.15886
	2	1.517	.593	.3593	.3177
	3	2.276	.889	.5389	.4766
	4	3.034	1.186	.7186	.6354
	5	3.793	1.482	.8982	.7943
	10	7.586	2.964	1.796	1.588
	2,000	1,517.2	592.8	359.28	317.72
Soy bean hay	1	.5489	.1127	.4231	.0174
	2	1.097	.225	.846	.034
	3	1.646	.338	1.269	.052
	4	2.195	.450	1.692	.069
	5	2.744	.563	2.115	.087
	10	5.48	1.12	4.23	.174
	2,000	1,097.80	225.40	846.20	34.80
Soy (soja) bean silage	1	.1522	.03069	.08930	.0159
	2	.304	.061	.178	.031
	3	.456	.092	.267	.047
	4	.608	.122	.357	.063
	5	.761	.153	.446	.079
	10	1.522	.306	.893	.159
	2,000	304.40	61.38	178.60	31.80

TABLE III. Showing Amount of Digestible Dry Matter and Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.—*Continued.*

Foods.	Weight. Lbs.	Dry Matter. Lbs.	Total Protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Peanut-vine hay	1	.5490	.0653	.4442	.0298
	2	1.098	.130	.888	.059
	3	1.647	.195	1.332	.089
	4	2.196	.261	1.776	.119
	5	2.745	.326	2.221	.149
	10	5.490	.653	4.442	.298
	2,000	1,098.00	130.60	888.40	59.60
Corn fodder (whole plant)	1	------	.0260	.3747	.00903
	2	------	.052	.749	.018
	3	------	.078	1.124	.027
	4	------	.104	1.498	.036
	5	------	.130	1.873	.045
	10	------	.260	3.747	.090
	2,000	------	52.00	749.40	18.06
Corn stover (whole plant, minus ears)	1	.4770	.02806	.4233	.0069
	2	.954	.054	.846	.013
	3	1.431	.084	1.269	.020
	4	1.908	.112	1.693	.027
	5	2.385	.140	2.116	.034
	10	4.770	.280	4.233	.069
	2,000	954.00	56.12	846.60	13.80
Corn tops, cut above ears	1	.5032	.0308	.4424	.0162
	2	1.006	.061	.884	.032
	3	1.509	.092	1.327	.048
	4	2.012	.123	1.769	.064
	5	2.516	.154	2.212	.081
	10	5.03	.308	4.42	.16
	2,000	1,006.40	61.60	884.80	32.40
Corn butts or stubble, portion below ears.	1	.3542	.0037	.3393	.0086
	2	.708	.007	.678	.017
	3	1.062	.011	1.017	.025
	4	1.416	.014	1.357	.034
	5	1.771	.018	1.696	.043
	10	3.542	.037	3.393	.086
	2,000	708.40	7.40	678 60	17.20
Corn husks or shucks	1	.6617	.0098	.6473	.0028
	2	1.323	.019	1.294	.005
	3	1.985	.029	1.941	.008
	4	2.646	.039	2.589	.011
	5	3.308	.049	3.236	.014
	10	6.617	.098	6.47	.028
	2,000	1,323.40	19.60	1,294.60	5.60
Pulled fodder, blades alone	1	.5464	.0534	.4334	.0196
	2	1.092	.106	.866	.039
	3	1.639	.160	1.300	.058
	4	2.185	.213	1.733	.078
	5	2.732	.267	2.167	.098
	10	5.464	.534	4.334	.196
	2,000	1,092.80	106.80	866.80	39.20
Corn silage, whole plant	1	.1491	.00726	.1328	.0040
	2	.298	.014	.265	.008
	3	.447	.021	.398	.012
	4	.596	.029	.531	.016
	5	.745	.036	.664	.020
	10	1.491	.072	1.328	.040
	2,000	298.20	14.52	265.60	8.00

TABLE III. Showing Amount of Digestible Dry Matter and Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.—*Continued.*

Foods.	Weight. Lbs.	Dry matter. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Timothy hay	1	.5190	.0303	.4630	.0121
	2	1.038	.060	.926	.024
	3	1.557	.090	1 389	.036
	4	2.076	.121	1.852	.048
	5	2 595	.151	2.315	.060
	10	5.190	.303	4.630	.121
	2,000	1 038.00	60.60	926.00	24.20
Red-top hay (Agrostis vulgaris)	1	.5212	.0465	.4475	.0094
	2	1.042	.093	.895	.018
	3	1.563	.139	1.342	.028
	4	2.084	.186	1.790	.037
	5	2.606	.232	2.237	.047
	10	5.212	.465	4.475	.094
	2,000	1,042.40	93.00	895.00	18.80
Orchard grass hay	1	.516	.0408	.4382	.0129
	2	1.033	.081	.876	.025
	3	1.550	.122	1.314	.038
	4	2.067	.163	1.752	.051
	5	2.584	.204	2.191	.064
	10	5.168	.408	4.382	.129
	2,000	1,033.60	81.60	876.40	25.8
Johnson grass hay	1	.4780	.0337	.3980	.0116
	2	.956	.067	.796	.023
	3	1.434	.101	1.194	.034
	4	1.912	.134	1.592	.046
	5	2.39	.168	1.990	.058
	10	4.780	.337	3.980	.116
	2,000	956.00	67.40	796.00	23.20
Mixed hays	1	.4593	.0299	.3788	.0104
	2	.918	.059	.757	.020
	3	1.377	.089	1.136	.031
	4	1.837	.119	1.515	.041
	5	2.296	.149	1.894	.052
	10	4.59	.299	3.788	.104
	2,000	918.60	59.80	757.60	20.80
Mixed hays (horse)	1	.4011	.036	.356	.00376
	2	.802	.072	.712	.007
	3	1.203	.108	1.068	.011
	4	1.604	0.144	1.424	.015
	5	2.005	.180	1.780	.018
	10	4.011	.360	3.560	.037
	2,000	802.20	72.00	712 00	7.520
Cattail, or pearl millet	1	.5578	.0622	.4211	.0091
	2	1.115	.124	.842	.018
	3	1.673	.186	1.263	.027
	4	2.231	.248	1.684	.036
	5	2.789	.311	2.105	.045
	10	5.578	.622	4.211	.091
	2,000	1,115 60	124.40	842.20	18.20
Sorghum fodder (leaves only)	1	.5525	.0584	.4582	.0212
	2	1.105	.116	.906	.042
	3	1.657	.175	1.364	.063
	4	2.210	.233	1.832	.084
	5	2.762	.292	2.291	.106
	10	5.525	.584	4.783	.212
	2,000	1,105.00	116.80	956.60	42.40

TABLE III. Showing Amount of Digestible Dry Matter and Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.—*Continued.*

Foods.	Weight. Lbs.	Dry matter. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Sorghum bagasse	1	.5378	.0047	.5218	.0067
	2	1.075	.009	1.043	.013
	3	1.613	.014	1.565	.020
	4	2.151	.018	2.087	.026
	5	2.689	.023	2.609	.033
	10	5.378	.047	5.218	.067
	2,000	1.075.60	9 40	1.043.60	13.40
Rice bran (sheep)	1	.8063	.0933	.5643	.0782
	2	1.612	.186	1.128	.156
	3	2.419	.280	1.693	.234
	4	3.225	.373	2.257	.313
	5	4.031	.466	2.822	.391
	10	8.064	.933	5.644	.782
	2,000	1,612.74	186.68	1,128.78	156.48
Oat straw	1	.4585	?	.4456	.0088
	2	.917	?	.891	.017
	3	1.375	?	1.336	.026
	4	1.834	?	1.782	.035
	5	2.292	?	2.228	.044
	10	4.585	?	4.456	.088
	2,000	917.00	?	891.20	17.60
Whole raw cotton seed	1	.5453	.0983	.2792	.1688
	2	1.090	.196	.558	.337
	3	1.635	.294	.837	.506
	4	2.181	.393	1.116	.675
	5	2.726	.491	1.396	.844
	10	5.453	.983	2.792	1.688
	2,000	1.090.60	196.60	558.40	337.60
Whole roasted cotton seed	1	.5069	.0756	.2909	.1611
	2	1.013	.151	.581	.322
	3	1.520	.226	.872	.483
	4	2.027	.302	1.163	.644
	5	2.534	.378	1.454	.805
	10	5.069	.756	2.909	1.611
	2,000	1,013.80	151.20	581 80	322.20
Cotton-seed meal	1	.6763	.3405	.2153	.0919
	2	1.352	.681	.430	.183
	3	2.028	1.021	.645	.275
	4	2.705	1.362	.861	.367
	5	3.381	1.702	1.076	.459
	10	6.763	3.405	2.153	.919
	2,000	1.352 60	681.00	430.60	183.80
Cotton-seed hulls	1	.3637	.00244	.3232	.0232
	2	.727	.0048	.646	.046
	3	1.091	.0073	.969	.069
	4	1.454	.0097	1.292	.092
	5	1.818	.0122	1.616	.116
	10	3.637	.0244	3.232	.232
	2,000	727.40	48.80	646.40	46.40
Wheat bran	1	.5192	.1197	.3684	.0282
	2	1.038	.239	.736	.056
	3	1.557	.359	1.105	.084
	4	2.076	.478	1.473	.112
	5	2.596	.598	1.842	.141
	10	5.192	1.197	3 684	.282
	2,000	1,038.40	239.40	736.80	56.40

TABLE III. Showing Amount of Digestible Dry Matter and Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.—*Continued.*

Foods.	Weight. Lbs.	Dry matter. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Corn meal (cows)	1	.7139	.0532	.5916	.0361
	2	1.427	.106	1.183	.072
	3	2.141	.159	1.774	.108
	4	2.855	.212	2.366	.144
	5	3.569	.266	2.958	.180
	10	7.139	.532	5.916	.361
	2,000	1,427.80	106.40	1,183.20	72.20
Corn meal (pigs)	1	.7553	.0785	.6456	.0321
	2	1.510	.157	1.291	.064
	3	2.265	.235	1.936	.096
	4	3.021	.314	2.582	.128
	5	3.776	.392	3.228	.160
	10	7.553	.785	6.456	.321
	2,000	1.510.60	157.00	1,291.20	64.20
Corn meal (goats)	1	.7139	.0532	.5916	.0361
	2	1.427	.106	1.183	.072
	3	2.141	.159	1.774	.108
	4	2.855	.212	2.366	.144
	5	3.569	.266	2.958	.180
	10	7.139	.532	5.916	.361
	2,000	1,427.80	106.40	1,183.20	72.20
Cowpeas (swine)	1	.7748	.1828	.5664	.00708
	2	1.549	.365	1.132	.014
	3	2.324	.548	1.699	.021
	4	3.099	.731	2.266	.028
	5	3.874	.914	2.832	.035
	10	7.748	1.828	5.664	.070
	2,000	1,549.6	365.6	1,132.8	14.16
Potatoes (swine)	1	.1962	.0155	.1733	------
	2	.392	.031	.346	------
	3	.588	.046	.519	------
	4	.785	.062	.693	------
	5	.981	.077	.866	------
	10	1.962	.155	1.733	------
	2,000	392.48	31.04	346.6	------
Rice bran, or douse (swine)	1	.8607	.0638	.7888	.0013
	2	1.721	.127	1.577	.0026
	3	2.582	.191	2.366	.003
	4	3.443	.255	3.155	.005
	5	4.303	.319	3.944	.006
	10	8.607	.638	7.888	.0130
	2,000	1,721.4	127.68	1,577.6	2.60
Rye bran (swine)	1	.592	.0972	.4747	.0161
	2	1.184	.194	.949	.032
	3	1.776	291	1.494	.048
	4	2.368	.389	1.898	.064
	5	2.960	.486	2.373	.080
	10	5.92	.972	4.747	.161
	2,000	1,184	194.0	949.48	32.34
Carrots (horse)	1	.0995*	.0113	.0709	------
	2	.199	.022	.141	------
	3	.298	.034	.212	------
	4	.398	.045	.283	------
	5	.497	.056	.354	------
	10	0.995	.113	.709	------
	2,000	199.04	22.64	141.84	------

TABLE III. Showing Amount of Digestible Dry Matter and Nutrients in 1, 2, 3, 4, 5, 10, and 2,000 Pounds of Feeding Stuffs.—*Continued.*

Foods.	Weight. Lbs.	Dry matter. Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.
Corn and cob meal (goats)	1	.6727	.0545	.5904	.0297
	2	1.345	.109	1.180	.059
	3	2.018	.163	1.771	.089
	4	2.690	.218	2.361	.118
	5	3.363	.272	2.952	.148
	10	6.727	.545	5.904	.297
	2,000	1,345.40	109.00	1,180.00	59.40
Corn and cob meal (pigs)	1	.6462	.0633	.5638	.0288
	2	1.292	.126	1.127	.057
	3	1.938	.189	1.691	.086
	4	2.584	.253	2.255	.115
	5	3.231	.316	2.819	.144
	10	6.462	.633	5.638	.288
	2,000	1,292.40	126.60	1,127.60	57.60
Whole corn (pigs)	1	.7704	.0840	.6465	.0362
	2	1.540	.168	1.293	.072
	3	2.311	.252	1.939	.108
	4	3.081	.336	2.586	.144
	5	3.852	.420	3.232	.181
	10	7.704	.840	6.465	.362
	2,000	1,540.8	168.00	1,293.00	72 40
Corn (horse)	1	*.780	.0809	.6515	.0332
	2	1.560	.161	1.303	.066
	3	2.340	.242	1.954	.099
	4	3.120	.323	2.606	.132
	5	3.900	.404	3 257	.166
	10	7.800	.809	6.515	.332
	2,000	1,560.0	161.80	1,302.92	66.40
Oats	1	.....	0876	.4611	.0394
	2	.....	.175	.922	.078
	3	.....	.262	1.383	.118
	4	.....	.350	1.844	.157
	5	.....	.438	2.305	.197
	10	.....	.876	4.61	.394
	2,000	.....	175.20	922.20	78.80
Oats (horse)	1	.597	.0904	.4795	.0342
	2	1.194	.180	.959	.068
	3	1.791	.271	1.438	.102
	4	2.388	.361	1.918	.136
	5	2.985	.452	2.397	.171
	10	5.971	.904	4.795	0.342
	2,000	1,194.22	180.96	959.08	68.40
Cowpeas, ground (horse)	1	.7416	.178	.5479	.0019
	2	1.483	.356	1.095	.003
	3	2.224	.534	1.643	.005
	4	2.966	.712	2.191	.007
	5	3.708	.890	2.739	.009
	10	7.416	1.780	5.479	0.019
	2,000	1,483.20	356 0	1,095.80	3.80
Cowpeas, ground (ruminants)	1	.757	.1827	.5401	.0117
	2	1.514	.365	1.080	.023
	3	2.271	.548	1.620	.035
	4	3.028	.731	2.160	.046
	5	3.786	.913	2.700	.058
	10	7.572	1.827	5.401	.117
	2,000	1,514.4	365.40	1.080.18	23.48

* Organic Substance.

TABLE III. SHOWING AMOUNT OF DIGESTIBLE DRY MATTER AND NUTRIENTS IN 1, 2, 3, 4, 5, 10, AND 2,000 POUNDS OF FEEDING STUFFS.—*Concluded.*

FOODS.	Weight. Lbs	Dry matter Lbs.	Total protein. Lbs.	Carbo-hydrates. Lbs.	Fats. Lbs.	Nutritive substance. Lbs.
Full cow's milk (calves)	1	.1474	.0309	.0536	.0534	.1441
	2	.294	.061	.107	.106	.288
	3	.442	.092	.160	.160	.432
	4	.589	.123	.214	.213	.576
	5	.737	.154	.268	.267	.720
	10	1.474	.309	.536	.534	1.442
	2,000	294.8	61.8	107.2	106.84	275.84
Buttermilk	1	.0851	.0305	.0442	.0025	.0805
	2	.170	.061	.088	.005	.161
	3	.255	.091	.132	.007	.241
	4	.340	.122	.176	.010	.322
	5	.425	.152	.221	.012	.402
	10	.851	.305	.442	.025	.805
	2.000	170.2	61.00	88.46	5.13	161.

II. FEEDING STANDARDS.

The composition and digestibility of feeding stuffs have been considered, and in the previous table the amounts of digestible nutrients in different quantities of foods were presented. The next question asked by the interested feeder is, How much and in what proportion should the digestible nutrients be fed to different animals for different purposes? This is a very difficult question to answer with accuracy. The results of a great many years patient investigation on this subject in Germany have found expression in the German Feeding Standards. In these, it has been attempted to give the needs of various animals, both as to amount of food and amount and proportion of digestible nutrients. The standards compiled by Wolff (tables IV and V) on this subject have been widely published and used in this country, and have, especially of late years, been the subject of discussion and criticism. We have no feeding standards of our own in America, and while the German ones no doubt need to be modified and changed to suit our climate, foods, and animals, yet the principle and example are good, and can serve as guides till we have accumulated sufficient data to formulate ones better suited to our particular needs.

It is to be remembered that the feeding standards presented do not represent invariable scientific facts, but are the average results of a great many carefully conducted experiments; then, too, the compositions and coefficients of digestibility of the feeding stuffs are the averages of analyses and digestion experiments. These facts borne in mind, the feeder will not expect certain definite results from them.

Another observation of interest in connection with feeding standards, is the greater proportion of protein to carbohydrates and fats

TABLE IV. FEEDING STANDARDS.—ACCORDING TO WOLFF.

Per day and per 1,000 *lbs. live weight.*

	Total organic substance.*	Nutritive (Digestible) Substances.			Total nutritive substance.**	Nutritive ratio.††
		Protein.	Carbohydrates.†	Fats.		
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
1. Oxen at rest in stall	17.5	0.7	8.0	0.15	8.85	1 : 12.0
2. Wool sheep, coarser breeds	20.0	1.2	10.3	0.20	11.70	1 : 9.0
Wool sheep, finer breeds	22.5	1.5	11.4	0.25	13.15	1 : 8.0
3. Oxen moderately worked	24.0	1.6	11.3	0.30	13.20	1 : 7.5
Oxen heavily worked	26.0	2.4	13.2	0.50	16.10	1 : 6.0
4. Horses lightly worked	20 0	1.5	9.5	0.40	11.40	1 : 7.0
Horses moderately worked	21.0	1.7	10.4	0.60	12.70	1 : 7.0
Horses heavily worked	23.0	2.3	12.5	0.80	15.60	1 : 6.0
5. Milk cows	24.0	2.5	12.5	0.40	15.40	1 : 5.4
6. Fattening oxen, 1st period	27.0	2.5	15.0	0.50	18.00	1 : 6.5
Fattening oxen, 2d period	26.0	3.0	14 8	0.70	18.50	1 : 5.5
Fattening oxen, 3d period	25.0	2.7	14.8	0.60	18.10	1 : 6.0
7. Fattening sheep, 1st period	26.0	3.0	15.2	0.50	18.70	1 : 5.5
Fattening sheep, 2d period	25.0	3.5	14.4	0.60	18.50	1 : 4.5
8. Fattening swine, 1st period	36.0	5.0	27.5		32.50	1 : 5.5
Fattening swine, 2d period	31.0	4.0	24.0		28.00	1 : 6.0
Fattening swine, 3d period	23.5	2.7	17.5		20.20	1 : 6.5
9. Growing cattle:						
Age. Mos. — *Av. live weight per head.*						
2— 3 — 150 lbs	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3— 6 — 300 lbs	23.4	3.2	13.5	1.0	17.7	1 : 5.0
6—12 — 500 lbs	24.0	2.5	13.5	0.6	16.6	1 : 6.0
12—18 — 700 lbs	24.0	2.0	13.0	0.4	15.4	1 : 7.0
18—24 — 850 lbs	24.0	1.6	12.0	0.3	13.9	1 : 8.0
10. Growing sheep:						
5— 6 — 56 lbs	28.0	3.2	15.6	0.8	19.6	1 : 5.5
6— 8 — 67 lbs	25.0	2.7	13.3	0.6	16.6	1 : 5.5
8—11 — 75 lbs	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11—15 — 82 lbs	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15—20 — 85 lbs	22.0	1.4	10.4	0.3	12.1	1 : 8.0
11. Growing fat pigs:						
2— 3 — 50 lbs	42.0	7.5	30.0		37.5	1 : 4.0
3— 5 — 100 lbs	34.0	5.0	25.0		30.0	1 : 5.0
5— 6 — 125 lbs	31.5	4.3	23.7		28.0	1 : 5.5
6— 8 — 170 lbs	27.0	3.4	20.4		23.8	1 : 6.0
8—12 — 250 lbs	21.0	2.5	16.2		18.7	1 : 6.5

NOTE.—The feeding periods mentioned in the above table have reference to the divisions of the whole time an animal is fed, and their respective lengths will depend on how long the animal is to be fed, its condition at beginning, and the judgment of the feeder.

*Represents the water-free food (or dry matter), less the ash.

†Nitrogen-free extract and crude fiber are taken together to form carbohydrates.

**Sum of the three preceding columns.

††See next page for explanation.

in the rations for young and growing animals, than in those for grown, fattening, and working ones. This is precisely as would be

TABLE V. Feeding Standards.

Per day and per head.

		Total organic substance.	Nutritive (Digestible) Substances.			Total nutritive substance.	Nutritive ratio.
			Protein.	Carbohydrates.	Fats.		
Growing cattle:	*Av. live weight*	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Age. Mos.	*per head.*						
2— 3	150 lbs.	3.3	0.6	2.1	0.30	3.00	1 : 4.7
3— 6	300 lbs.	7.0	1.0	4.1	0.30	5.40	1 : 5.0
6—12	500 lbs.	12.0	1.3	6.8	0.30	8.40	1 : 6.0
12—18	700 lbs.	16.8	1.4	9.1	0.28	10.78	1 : 7.0
18—24	850 lbs.	20.4	1.4	10.3	0.26	11.96	1 : 8.0
Growing sheep:							
5— 6	56 lbs.	1.6	0.18	0.87	0.045	1.095	1 : 5.5
6— 8	67 lbs.	1.7	0.17	0.85	0.040	1.060	1 : 5.5
8—11	75 lbs.	1.7	0.16	0.85	0.037	1.047	1 : 6.0
11—15	82 lbs.	1.8	0.14	0.89	0.032	1.062	1 : 7.0
15—20	85 lbs.	1.9	0.12	0.88	0.025	1.026	1 : 8.0
Growing fat swine:							
2— 3	50 lbs.	2.1	0.38	1.50		1.88	1 : 4.0
3— 5	100 lbs.	3.4	0.50	2 50		3.00	1 : 5.0
5— 6	125 lbs.	3.9	0.54	2.96		3.50	1 : 5.5
6— 8	170 lbs.	4.6	0.58	3.47		4.05	1 : 6.0
8—12	250 lbs.	5.2	0.62	4.05		4.67	1 : 6.5

Note.—The German pound equals 1.1 pounds avoirdupois. The above figures should therefore be increased correspondingly to represent American pounds, but in practice this is probably not necessary, since these weights represent only the approximate needs of the animals.

expected, since the bodily frame-work of the young animal is being built up at this stage of growth, and hence requires a larger proportion of protein, or flesh formers.

Nutritive Ratio.

"Total organic matter" in the above tables represents the water-free food, minus the ash; the "total nutritive substance" is the sum of digestible protein, carbohydrates, and fats; and the "nutritive ratio" is the ratio of the digestible protein to the sum of the digestible carbohydrates and fats, the fats being previously multiplied by 2.5 *

It will be seen from table IV that the standards are for animals of 1,000 pounds live weight. The standards are to be increased or diminished in proportion as the weight of the animal is greater or less than 1,000. In table V, they have been thus calculated to correspond with the weights of some animals weighing less than 1,000 pounds.

* Experimenters and feeders now generally use factors varying from 2.2 to 2.27 for bringing fats to the same nutritive basis as carbohydrates, and we agree with them that these factors are more nearly correct than 2.5; but we adhere to the latter in order that our ratios may be comparable with those in the German standard.

III. HOW STOCK RATIONS CAN BE CALCULATED.

A ration is the amount of food eaten by an animal per day. Table III contains data in a most available and handy form for compounding rations to correspond with the German standards just given, or with any other formula which may have proven valuable in the experience of the individual feeder; or for estimating the amounts of digestible nutrients the farm animals may now be consuming

An example or two will make sufficiently clear the calculation and compounding of rations, so that the feeder, by applying results in table IV to whatever foods he may have, can make up rations to correspond with whatever formula he may wish. Suppose we want to compound a ration for a 1,000 pound milch cow, and have corn silage, cowpea-vine hay, corn meal, and cotton-seed meal from which to make it up. By reference to table III, we find the following amounts of nutrients corresponding to the weights of food taken.

Foods Taken.	Weight. Lbs.	Digestible.		
		Protein. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.
Corn silage	30	.216	3.984	.120
Cowpea-vine hay	12	1.117	4.605	.148
Corn meal	5	.266	2.958	.180
Total	47	1.599	11.547	.448

Using the amounts of corn silage, cowpea-vine hay, and corn meal for making the ration, it falls only slightly below the standard in amounts of carbohydrates and fats, but is notably deficient in protein, so we need to add to it a small quantity of some food rich in protein. Cotton-seed meal is a common food with us, and a good one for this purpose. We will then add to the ration as above, $2\frac{1}{2}$ pounds of cotton-seed meal:

Foods Taken.	Weight. Lbs.	Digestible.		
		Protein. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.
Ration as above	47	1.599	11.547	.448
Cotton-seed meal	$2\frac{1}{2}$	.840	.575	.240
Total	$49\frac{1}{2}$	2.439	12.122	.688
Standard for 1,000-pound cow	--	2.50	12.50	.40

Nutritive ratio of above ration, 1 to 5.67, obtained thus: (fats .688×2.5) +carbohydrates, (12.122) = 13.842 13.842÷protein, (2.439) = 5.67.

The 2½ pounds cotton-seed meal are thus seen to bring the ration very near the German standard for a 1,000-pound milch cow. There is a deficiency of carbohydrates, but the excess of fats compensates for this. It is near enough the standard for all practical purposes. The proportion of the foods in the above ration is not absolute and unchangeable, but may be varied in a number of ways, so as to get practically the same amounts and proportions of digesitible nutrients. What we would have understood is that the above is not the only ration that can be made from those foods containing those quantities of digestible nutrients, but a number may be by varying the proportions of them. This the feeder will have to do for himself, taking into account the quantity and foods he may have and the purposes for which he is feeding. The above is merely an example. If the animal weighs 700 or 800 pounds take seven-tenths ($\frac{7}{10}$) or eight-tenths ($\frac{8}{10}$) of the ration for the 1,000-pound animal, or whatever proportion the weight bears to 1,000.

It will be observed that the total "organic matter" was calculated in the feeding standards, but not in the ration presented above. Organic matter is merely a measure of the bulk of the ration, and, if the ration is not made too bulky, or too concentrated, it need not be further considered.

IV. SOME RATIONS FED IN NORTH CAROLINA, AND SOME RATIONS SUGGESTED.

On December 16, 1893, the Station sent to various feeders in the State inquiries relating to the care of stock. The following is extracted from this circular of information:

INQUIRIES AS TO CARE OF STOCK, AND FOOD AND RATIONS GIVEN.

DEAR SIR:—The N. C. Agricultural Experiment Station is carrying on some investigations with cattle foods, feeding, and care of stock, and it would be of service to us to get some information from breeders and feeders of stock in different parts of the State on these subjects. You will therefore confer a favor by a prompt reply to this circular, and by giving as definite information as possible on as many points as you can.

1. (*a*) What breed of cattle have you? (*b*) Purpose for which kept. (*c*) Sheep. (*d*) Swine. (*e*) Horses.

2. Give average number of each breed kept.

3. What part of the year does stock support itself by grazing?

4. What foods are used the remainder of the year, and how much of each?

5. What coarse food or grain is purchased, and what price for each article? Average prices are desired.

6. (*a*) Have you fed silage? (*b*) If so, to what stock, (*c*) and what crops were ensilaged? (*d*) Do you continue to use silage, and what crop do you favor as best for silage? Feeding stock—give your common or favorite ration with silage, or if you do not use silage, your most common ration of other foods for each kind of stock.

7. (*a*) What feeds do you give horses, and how much is allowed per day in pounds? State price or value per ton. (*b*) What feeds do you give mules? (*c*) What feeds do you give colts? (*d*) What feeds do you give cows? (*e*) What feeds do you give beeves? (*f*) What feeds do you give heifers? (*g*) What feeds do you give bulls? (*h*) What feeds do you give sheep? (*i*) What feeds do you give swine?

This circular was distributed to secure information in regard to feeding farm stock as practiced throughout the State. It was the desire of the Station, in turn, to distribute the information collected in this way, and thus give some knowledge of the best practices to those who have had least experience, and who will be best able to profit by the counsel of those who have made specialties in the several lines of feeding.

A considerable number of replies have been received from all sections of the State, and the practices and kind of feeds reported probably cover the range of foods and rations in common use. Some of these are given in the following pages.

It may not be out of place to remark here, that in the digestion work which has been done by the Experiment Station, there has been a greater proportion of digestible food obtained from coarse home-grown fodders, rich in carbohydrates, as fodder, shucks, straw, hay, corn silage, and cotton-seed hulls, when they have been fed with easily digestible by-products which are rich in the opposite class of protein compounds. Of this class of foods there are none to equal cotton-seed meal. It is safe in moderate quantities for nearly all domestic animals. The pig is the only animal we know of that is sure to be injured by cotton-seed meal.

Whenever a food like stover, shucks, straw, or coarse hay is to be fed, it is economical in effectiveness of the ration on the stock, to combine with it something else which carries with it a comparatively large proportion of protein. This may be obtained from clover, pea-vine, peanut, soy bean, or vetch hay, or silage made from these plants, or from by-products of the common grain foods.

It will thus become apparent to the stock-raiser that it will be to his advantage to raise the class of food needed to balance the coarse fodders produced on the farm, rather than purchase them. But many farms are not in condition to grow these at once. To help bring up the land to a productive state it is good practice to buy such cattle foods as cotton-seed meal, wheat bran, rice products, the grains when cheap enough, feed them to thrifty stock, and bestow careful attention on the manure piles and their application to the soil.

We would urge each feeder to learn to combine the foods he has, in order to produce rations as near as possible to the standards given in this bulletin. Then he should feed the ration in the proportions calculated, and as much to each animal as can be eaten up clean and regularly, without cloying the appetite of the animal.

It is never well to be dosing with condiments or stimulants, and yet it is both humane and economical to keep at hand a small stock of simple remedies for animals, to be administered when needed, but in no case unless the disease is known as well as the right remedy which ought to be employed. If any serious trouble ensues, a veterinarian should be consulted, but such simple things as salt and ashes, or copperas for worms, salts for derangements of digestion,

mucilage or sweet spirits of nitre, or of charcoal supplied to pigs, should be employed whenever their need is apparent. Common salt should be supplied freely to all animals. It is better to supply it in large solid lumps where the stock can lick off what they want at pleasure, than to depend on "salting" once or twice a week, or oftener. This salt will stand the weather well enough to be put out in pastures. A few animals may be found that will eat too much salt if thus provided, but they will be fewer than those that will get too much from periodic salting, if enough is allowed so all will get a taste in the pasture, as the greedy ones will secure the lion's share and suffer accordingly.

As might have been expected there are great differences in the time stock is self-supporting on the range. Not only is this difference graded somewhat for different classes of stock in a given locality, but by different management and care bestowed. In the East some stock is able to subsist with little or no attention, while some are fed for one, two, or three months, or are given a little food to supplement what can be gleaned during the shortest grazing month or two. The grazing season shortens toward the West until it is seven, six, or five months in the mountains, and feeders find it advantageous to feed the rest of the year. For dairy stock, even when ordinary animals may find support five to eight months, some foods are added to the dietary with advantage for nearly the whole of the grazing season. This shows that there is a growing recognition of the fact that the profits do not accompany self-support or feeding for maintenance, but follow in close connection the excess of food digested above what is required for support. It is also noticeable that dairymen, dealing with the maternal instincts and secretions where the most sensitiveness to adverse changes exist, find this out and profit by it before other feeders have awakened to the importance of considering the cost of food and feeding as secondary to the effect produced. This is doubtless true to some extent in housing stock. To provide comfortable quarters during cold or stormy weather, and shade or darkened sheds for protection against sun and troublesome insect pests not only marks an advance, but also points out the man who is looking for the little drains and leaks which absorb the profits of stock breeding.

Some Rations Which Are Being Fed in North Carolina.

RATIONS FED TO HORSES.

Few feeders give any definite quantities to their animals, or measure the food by the size or necessities of individuals, as might with propriety be suggested. Yet they often get the quantities with a pitchfork or pail much nearer the horse's needs than they know themselves. Oats are considered one of the best, if not the best, food for horses. Wheat bran is also a favorite food.

Adaptability to the purpose for which the animal is intended has

an important part in the selection of the dietary for horses. The young must be fed for growth, a good development of the muscles, and for strength and density of bone. Grazing on good grasses and clovers may be ideal foods for this purpose, but for part of the year colts must be fed for proper development. Some oats and bran and other foods are generally supplied, and it is quite natural to supply a certain ration of these most valuable and expensive foods, and then enough of the coarse, rough food for each one to get all that is needed for its complete sustenance, and to spare for the strengthening of the system by exercise.

Horses are not divided into classes here, but are treated generally, and rations may be included below for work on farm, draft, or road, and speed. This paper must be too brief to discuss these distinctions. Following are some rations which have been reported to the Station:

Rations fed to Horses.

1. Hay and cut corn stalks, cured from sowed corn. No silage.
2. A diversity of fodder, silage, corn, dry fodder, straw, cut sheaf oats. (This feeder doubtless gives wheat bran, and probably some threshed oats.)
3. Mixed feed; 3 pounds meal on oats and fodder mornings, with corn at noon and night, amounting to 10 pounds grain per day and head.
4. { Corn, 8 lbs, $15 per ton. / Hay 20 lbs, 8 per ton. } or { Fodder, 12 lbs, $20 per ton. / Oats, 15 lbs, 30 per ton. }
5. Corn, 10 pounds, at 60 cents per bushel; chop at $25 per ton.
6. Fodder and hay, corn and rye chop, all they will eat up clean.
7. Corn, 12 pounds; fodder, 5 pounds; hay, 5 pounds. Corn, at $17.85 per ton. Fodder and hay, $25.
8. Fodder, 15 pounds; corn, 10 pounds. Mules: fodder, 10 pounds; corn, 7 pounds.
9. 24 ears corn per day (about 150 to bushel), and all the forage they will eat at night.
10. Fodder, 4 pounds; straw, 6 pounds, corn; 12 pounds.
11. All the hay they will eat, and 8 ears of corn.
12. Corn fodder, oats, shucks, etc.
13. Corn fodder, ensilage, crushed corn, with cobs, and some turnips. Feed about what they will eat up clean.
14. Corn, oats, fodder, and hay. As much as they will eat without waste.
15. Cut shucks, or oats, and 1½ to 2 gallons corn meal per day. Mules same.
16. Corn and marsh hay.

Rations fed to Colts.

3. Same as for horses, only less. (See No. 3 above.)
4. Same as horses, meal, bran, oats, and fodder.
4½. Grass in summer, and corn, oats, and fodder in winter.
6. Wheat bran and corn meal mixed, and timothy hay.
9. 1 gallon oats, ½ gallon bran, and all the forage they will eat.

There have been so few digestion experiments made with horses, and these all foreign work and mostly on foods not included in the rations given above, that it is not easy to give calculated rations without assuming a great deal as to probable digestibility. There are a few, however, which may be compared with the recognized standard for horses, and in a general way some rational combinations can be suggested. It will be remembered by most horse owners and feeders that the stomach of the horse differs from that of the cow, sheep, or goat in capacity, and hence he must be fed somewhat more concentrated food than they to thrive as well. The horse should be well nourished for work, but should not be put at work with a great bulk of food in his stomach. Hence rations made up wholly or in large part of coarse or poorly digestible foods are badly suited to the needs of the animal and must fail to support the weight, or to keep him growing, or bearing daily burdens with cheerfulness, whether at the plow, wagon, sulky, or under saddle.

The rations must be adequate to the demand made on the animals. For this purpose they must contain a given amount of digestible compounds which have been found to be essential to animal nutrition, and these should be present in definite proportions as has been shown. These are according to Wolff's standard for 1,000-pounds live weight:

	Total organic substance. Lbs.	Nutritive (Digestible) Substance.				
		Albuminoids. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.	Total nutritive substance. Lbs.	Ratio 1:—
Horses moderately worked	22.5	1.8	11.2	0.60	13.60	7.
Horses heavily worked	25.5	2.8	13.4	0.80	17.00	5.5

Unless rations Nos. 1 and 2 are fed with some grain or nitrogenous food, as clover hay, the animals would not be able to bear any continuous exertion without loss of flesh. Number 3 is a better ration for work and compares with the above standards as follows. We must suppose some certain amounts are fed; as 6 pounds corn, 4 of oats, and that with this the equivalent of 15 pounds of average hay has been consumed. This allows the digestible matter of the ration to have been

	Organic matter. Lbs.	Protein. Lbs.	Carbohydrates Lbs.	Fats. Lbs.	Total nutritive substance. Lbs.	Ratio 1:—
15 pounds meadow hay (average)	11.979	0.539	5.340	0.056	5.935	
6 pounds corn	5.276	0.486	3.909	0.199	4.594	
4 pounds oats	3.444	0.362	1.918	0.137	2.417	
	20.699	1.387	11.167	0.392	12.946	8.75

This shows a deficiency of protein and fat. It is also low in organic matter, and the ratio is rather wide for light work. It will answer very well, however, for horses or mules of 850 to 950 pounds weight; and will doubtless prove a sustaining ration for such stock at ordinary work. Substituting for the oats 5 pounds of cowpeas, which cost about the same, and adding 5 pounds of hay, gives a better ration for work, and one which will sustain a heavier horse, or the same horse at harder work than he could do on the third ration above. This would contain:—

	Organic matter	Digestible Matter in Pounds.				Ratio 1:—
		Protein.	Carbohydrates.	Fat.	Nutritive substance.	
Hay, 20 pounds	15.992	0.719	7.120	0.0747	7.913	
Corn, 6 pounds	5.276	0.486	3.909	0.199	4.594	
Cowpeas, 5 pounds	4.099	0.891	2.739	0.010	3.734	
	25.367	2.096	13.768	0.2837	16.241	6.9

Most of the hay should be fed at night, and least at noon, if any at all. This ration contains enough organic matter and an excess of carbohydrates, with a deficiency in protein and fat. It will doubtless sustain a 1,000 pound horse on medium to heavy work. This would need an occasional feed of roots, or green fodder.

The following would be a better ration than either of the above for light work, and it could be fed month in and out for a year, if desired:

	Organic matter.	Digestible Matter in Pounds.				Ratio 1:—
		Protein.	Carbohydrates.	Fat.	Nutritive substance.	
16 pounds hay, 4 pounds corn, 4 pounds peas. *1½ pounds ground flax seed	1.79	1.078	.729	13.75	13.45	7.

*From Stewart's Feeding Animals, p. 157.

For colts, the last named ration may be regarded as a good one, yet it would be improved by substituting 3 pounds of wheat bran for 3 of the corn, and feed only such portion of the whole ration as the colt's weight bears to 1,000 pounds, or, possibly, a little more than strict proportion would allow. Number 9 is a very good colt ration, if the "forage" is of good material and well cured.

Some Rations Fed to Milch Cows.

1. Cotton seed and bran, 3 to 6 pounds per day.
2. Ground and cooked peas, wheat foods, silage from 2 silos, 10 x 10 x 14. Cotton-seed hulls, corn meal. The foods are changed often.
3. Mixed feed twice per day, with corn and cob meal once.
4. Cotton seed, meal and bran, corn shucks and hay.
5. Straw, at $4, shucks, nubbins, chop.
6. Corn chop, and hay, or fodder.
7. Meal, 7 pounds; fodder, 5 pounds; hay, 5 pounds; cotton seed, 5 pounds.
8. Shucks and pea-vine hay, 7 pounds, at $10, and 3 pounds wheat bran and shorts, at $20.
9. Cotton seed, 7 pounds, with one gallon of the following mixture: Corn, 2 bushels, oats, 1 bushel, wheat bran, 1 bushel.
10. Cotton seed, 6 pounds; pea meal, 10 pounds. Do not stall feed. Dry cows all the straw and shucks they will eat.
11. Fodder mornings and hay evenings.
12. Shucks, straw, turnips, pumpkins, potatoes, short corn, bran, etc
13. All stock supports itself the year through. (From Carteret County.)
14. Corn fodder, ensilage, crushed corn with cobs, some turnips.
15. Shucks, straw, chaff, clover and pea hay, with some corn meal, wheat bran, and cotton seed.
16. Cut shucks, and 1½ gallons corn meal to cows.
17. Hay, beets, turnips, and bran. Cotton seed and hay and corn. Wheat bran and cotton seed and shucks.

Most of these rations are not definite enough to make a calculation on, but a few of them have been so stated that they can be used. If feeders will only weigh and measure and observe proportions a little more closely, they can save themselves money by lessening the cost of feeding, and in increasing the value of the products.

Ration No. 2 presents some good and cheap foods, but no amounts are given. In the following calculation all the amounts are assumed:

	Protein.	Carbohydrates.	Fat.	Nutritive substance.	Ratio.
5 pounds wheat bran	.598	1.842	0.141	2.581	
40 pounds silage	.288	5.312	0.16	5.76	
5 pounds cowpeas* (ground)	.914	2.700	0.059	3.637	
	1.800	9.854	0.36	12.014	5.9

*Digestion coefficients for field beans. Zusam. u. Verd. der Fut., 1891.

	Organ. Sub.	Nitrogenous.	Fat.	N-free ext.	Fiber.
With ruminants, p. 1214	88.88	88.05	81.51	91.69	71.89
Same from p. 1111	89.29	88.12	86.67	91.63	71.89
Our own average of the 14 determs. given on p. 1111 is	90.77	90.54	89.46	92.24	70.32

This ration was calculated using the ratios given on page 1216 of Zusammensetzung und Verdaulichkeit der Futtermittel, von Dr. Th. Dietrich und Dr. J. König. Afterwards looking over the experiments on which the average was based, we were struck by the discrepancy of the mean figures (pages 1111 and 1214). On averaging the 14 determinations given, the mean obtained was different from either of those given in the book. Some of the published figures must be in error therefore, but the first calculation is allowed to stand unchanged until a proper correction can be made.

This ration would be a very good one, and quite sufficient for an average cow of 800 pounds weight. It contains a slight excess of carbohydrates, and is a little deficient in protein, which makes the ratio rather wider than the standard. The average cow will probably leave some of the silage, and will thus reduce the portion consumed to a close approximation to the standard. For larger cows make it 50 pounds silage, 5 of bran, and 7 of peas. The composition will then stand about as follows:

	Protein.	Carbohydrates.	Fat.	Nutritive substance.	Ratio.
50 corn silage 5 wheat bran 7 cowpeas	2.24	12.26	.384	13.48	5.9

If this is increased by one-ninth of itself it will closely approximate the standard for 1,000 pounds live weight, but in practice we have found rations under the standard to meet the needs of our stock. The ration consumed will be farther than the above from the standard. A ration often fed at the Experiment Farm to cows of about 900-pounds weight consists of:

	Protein.	Carbohydrates.	Fat.	Nutritive substance.	Ratio. 1:—
45 corn silage	0.324	5.976	0.18		
3 cotton-seed meal	1.021	.645	0.275		
6 Wheat bran	0.718	2.310	0.169		
	2.063	8.931	0.624	11.618	5.1

This ration, measured by the recognized standard, appears to be deficient in quantity, but has been fed to a 1,000-pound cow, and proved sufficient when five to six months in calf and milking five to seven pounds ($\frac{3}{4}$ gallon) of milk per day. Another cow in full flow of milk, $3\frac{1}{2}$ gallons per day, was fed 80 pounds of green rye, and 5 pounds hay, with 9 pounds cotton-seed meal and bran mixed two to one. The following was eaten:

	Total dry mat.	Protein.	Carbohydrates.	Fat.	Nutri. sub.	Ratio 1:—
75 pounds rye	11.75	1.483	6.1725	.428	8.083	
3 pounds cotton-seed meal, 6 pounds wheat bran,	8.02	1.739	2.955	.444	5.138	
	19.77	3.222	9.027	.872	13.221	3.48

The ration given under No. 7 can be thus stated:

	Protein.	Carbohydrates.	Fat.	Nutritive substance.	Ratio.
Corn meal, 7 pounds	.372	4 141	.252		
Corn fodder, 5 pounds	.267	2.167	.098		
Hay, 5 pounds	.149	1.894	.052		
Cotton seed, 5 pounds	.491	1.396	.844		
	1.179	9.598	1.246	12.023	10.78

To improve this ration and make it correspond closely to the standard, except less carbohydrate and a large excess of fat, the corn meal should be dropped, and 4 pounds of cotton-seed meal added, with 5 pounds more of fodder. The ration would then stand as follows:

	Protein.	Carbohydrates.	Fat.	Nutritive substance.	Ratio 1:—
Pulled corn fodder, 10 pounds	.534	4.334	.196		
Hay, 5 pounds	.149	1.894	.052		
Cotton seed, 5 pounds	.491	1.396	.844		
Cotton-seed meal, 4 pounds	1.362	.861	.367		
	2.538	8.485	1.459	12.482	4.78

This would do very well for a cow of 1,000 to 1,100 pounds, and perhaps would support 1,200 pounds weight.

A Guilford County dairyman's ration is as follows:

	Cost. Cents.	Digestible protein.	Carbohydrates.	Fat.	Nutritive substance.	Ratio 1:—
Cotton-seed hulls, 20 pounds	4.25	.0488	6.464	.464		
Hay, 5 pounds	2.50	.1495	1.939	.052		
Oat straw, 5 pounds	0.625	.070*	2.228	.044		
Cotton-seed meal, 3 pounds	3.60	1.008	.691	.288		
Corn meal and bran, 7½ pounds (Taken as 5 and 2½.)	8.25	.266 .299	2.958 .911	.180 .0705		
	19.225	1.841	15.191	1.099	18.131	9.76

Suppose he changes to the following:

Hay, 10 pounds	5.00	.299	3.878	.104		
Oat straw,* 20 pounds	2.50	.280*	8.912	.176		
Cotton-seed meal, 5 pounds	6.00	1.681	1.152	.480		
Corn meal, 2 5 pounds	2.75	.133	1.479	.090		
Wheat bran, 2.5 pounds	2.75	.299	.811	.0705		
	19.00	2.692	16.332	.9205	16.945	6.92

This calculation is based on the tabulated analyses given in bulletin No. 90. Probably cows will leave some straw which will reduce the nutritive substance and ratio, and as his cows doubtless fall short of 1,000 pounds this ration should prove sufficient for them.

The additional rations given below will be found of interest in this connection :—

Rations with annual clover hay. *Ration No. 1:* One cow of nearly 700 pounds weight (697) was fed 18 pounds of hay daily for some time; she ate 14.64 pounds. See ration No. 1 below. *Ration No. 2* was fed to the same cow. Corn meal is a better combination with this hay. *Ration No. 3:* Crimson clover hay, oat straw, and a mixture of wheat bran 2, ground oats 2, and corn meal 1, was fed a growing bull. *Ration No. 4:* Feed allowed dry cows November, 1892, at the Experiment Farm.

*Stewart's Feeding Animals, p. 155.

Name and Amount of Article Fed.	Total dry matter. Lbs.	Digestible Substance.				Ratio 1:—
		Protein. Lbs	Carbohydrates. Lbs.	Fats. Lbs.	Nutritive substance. Lbs.	
Ration No. 1.						
Crimson clover hay alone. Fed 18 pounds; eaten, 14.64	13.05	1.625	5.702	.24	7.568	3.88
Am't of above per 1,000 live weight	18.72	2 331	8.181	.344	10.856	
Ration No. 2. Fed to same cow:—						
Fed 18 lbs. crimson clover hay; eaten, 14.24	12.693	1.580	5.546	.233		
Fed 4½ lbs. cotton-seed meal; eaten, 4.50	4.152	1.552	.924	.461		
	16 845	3.132	6.470	.694	10.296	2.66
Am't. per 1,000 lbs. live weight	23.139	4.302	8.887	.953	14.142	
Ration No. 3. Eaten by bull.						
10½ crimson clover hay	9.361	1.307	4 587	.131		
10½ oat straw	9.490	.1512	4.475	.069		
4 wheat bean	3.508	.572	1.706	.103		
4 ground oats	3.560	.338	1 844	.157		
2 corn meal	1.684	.124	1.235	067		
31. Total consumed for 1,400 lbs weight	27.603	2.492	13.847	.528	16.867	6 25
Standard for age 18–24 mos. and 850 lbs. weight per 1,000 live weight	24.00	1.60	12.00	0.3	13 90	8.00
Standard raised for 1,400 lbs	33.6	2.24	16.80	0 42	19.46	

On a ration containing approximately two (2) ounces more of fat, and four (4) ounces of protein, with three (3) pounds less of carbohydrates than would be required in strict proportion for an animal of this weight according to the ratio, there was a gain of 2.2 pounds per day for the growing bull fed on ration No. 3

Name and Amount of Article Fed.	Total dry matter. Lbs.	Digestible Substance.				Ratio 1:—
		Protein. Lbs.	Carbohydrates. Lbs.	Fats. Lbs.	Nutritive substance. Lbs.	
Ration No. 4.						
20 lbs. cotton-seed hulls	17.08	.056	6.026	.592		
5 lbs. { cotton-seed meal 1 / wheat bran 2 }	4.46	.973	1.621	.265		
	21.54	1.029	7.647	.857	9.533	9.5

The rations suggested below are reprinted from bulletin No. 80, page 14, and give combinations with corn silage in various proportions.

"Rations for stock to include silage may be made in endless variety, according to the animals to be fed, the object of feeding, and the other foods available to be used with it. Silage from well-matured corn will keep stock in store or growing condition, and some may even fatten slowly on it; but for fattening, growth, work, or production of milk, best results require some other food more highly nitrogenous to be used with the silage. Of these cotton-seed meal is one of the best. In this State, where cotton-seed meal is a by-product and can be purchased without great cost for transportation, it should become one of the common staple articles of cattle food. Cotton-seed meal alone is one of the best additions to silage for a good ration for milk or beef. Below are given some rations which may be fed to milch or beef-cattle of 700 to 800 pounds weight and for about 1,000 pounds. The first figure under each number are for the smaller animal:"

	No. 1. Pounds.	No. 2. Pounds.	No. 3. Pounds.	No. 4. Pounds.	No. 5. Pounds.	No. 6. Pounds.	No. 7. Pounds.
Corn silage	30 40	40 50	24 30	30 40	.....	30 40	
Cotton-seed meal	4 5	3½ 4½	.....	.....	.....	.....	2¼ 3
Cotton-seed hulls	8 10	.....	4 5	.....	.....	.....	6 7½
Clover hay	.....	.....	.....	.....	13 17½	.....	8 10
Hay, cowpea-vine	.....	.....	.....	12¼ 15	.....	.....	
Orchard-grass hay	.....	4 5	.....	.....	.....	.....	
Lucerne, or alfalfa	.....	.....	8 10	.....	.....	.....	
Corn meal	.....	.....	.....	.....	4½ 6	.....	6 7½
Wheat bran	.....	.....	5 6	.....	3 4	4½ 6	2 2½
Field peas, ground	.....	.....	.....	.....	.....	4½ 6	
Total lbs. in rations	42 —55	47½—59½	41 —51	42½—55	20½—27½	39 —52	24¼—30½

Rations fed to Beeves.

4. Chop and nubbins.

7. Meal, 13 pounds; fodder, 5 pounds; cotton seed, 8 pounds.

9. Only keep 8 to 10 head to eat up shucks and refuse forage. Haul up cornstalks and cattle strip them. Turn on clover and feed stronger in March. Give cotton seed, bran, and nubbins, corn and meal, and sell when only in fair condition.

10. All the straw they will eat, and 2 or 3 quarts of cotton seed per day.

12. (Same as cows.)

14. (Same as horses, mules and cows.)

15. (Same as cows.)

16. Corn meal.

18. Pasture.

Rations fed to Young Stock and Bulls.

1. Only pea vines, oat straw, and cut cornstalks.

5. Straw, shucks, small quantity chop.

6. (Same as cows.)
7. Corn meal, 3 pounds, fodder or hay, 6, cotton seed, 3.
14. (Same as horses and mules.)
15. (Same as cows.)

The rations fed to beeves indicate thriftiness in utilizing the waste products of the farm. This was urged in a former bulletin (No. 81), where, in discussing the result of a feeding experiment, it was stated that, "*It pays to use up all rough cattle food which can be gathered, and at a season when it is at its best*, that is, perishable articles, as potatoes, roots, garden waste early in the season, in connection with cotton-seed hulls and meal." In order to succeed best with such feeding, it must be done rationally. Thus, if in No. 9, above, the cattle are fed cotton seed in limited amount when on clover, or while being fed on shucks, refuse, and cornstalks, then they should be fed some richly nitrogenous food or by-product of smallest possible cost to balance ration and get the most out of the coarse food. Compare bulletin 87D, p. 32, p. 47. See also parts C. and D. of bulletin 93 on this subject. It does not pay a feeder to sell off stock when only in fair condition. Stock should be prepared for market when it is likely to bring the best prices, and in the fattest condition the market will pay for. Nearly every ration for beef would be improved by addition of cotton-seed meal.

We might lay down as a general rule for the advantage of the stock fed for gain in total amount digested from the coarse foods for beef, and an advantage also in increasing the value of manure, is to *give every animal a daily ration of cotton-seed meal equal to one-half pound for every 100 pounds of live weight, and all the roughage it will eat*, and you cannot go very far astray in your ration, especially if the animals get a little green grass or clover in addition. Where plenty of clover, cowpea-vines, peanut vines, or soy-bean fodder can be had, corn meal may be used instead of cotton-seed meal. With the directions given previously in this bulletin any feeder can easily "balance" the ration out of such foods as he may have, or can easily procure.

For some additional rations for beeves, see discussion in this bulletin under cows, page 307; also refer to bulletins 81 and 93, and to those on digestion, 80C, 87D, and 97.

Rations fed to Sheep.

3. Clover hay, meal, fodder, etc.
4. Oats, cotton-seed meal, and fodder.
5. Small quantity of corn and top fodder.
6. Corn and fodder.
7. Grain, 1 lb.; hay, 1 lb.; fodder, 1 lb.
10. Cotton-seed with corn mostly, and fodder. Never has weighed.
11. Fodder and corn.
12. Cotton-seed mostly, peas, etc.
15. Rag-weed hay, shucks, chaff and cotton-seed with meal and bran.

17. Hay, turnips, and corn. (Feeding 100 to 200 Shropshires.)
17½. Corn and turnips.
18. Cotton-seed in severe weather.

This list of rations shows that few if any breeders are accustomed to feed sheep more than enough to assist bare pastures or to help the sheep over severe periods in winter or spring. More care and feeding ought to pay well, especially with ewes and early lambs and fattening mature sheep. It is a good practice to keep corn or meal, cowpeas or bran, or cotton-seed where the growing lambs can get to it every day at will, besides what they can get from the troughs when the dams are fed once every day with bran, corn, peas or beans, or in place of these, cotton-seed meal.

Feeding from 4 to 6 ounces of cotton-seed meal per day and head, with what coarse food the sheep can get from rather poor pasture, or from straw, poor hay, or stover, would keep a flock in good condition. One-half pint to one pint of beans or peas should have about the same effect. Quiet and gentle handling to keep the animals tame and free from excitement are valuable adjuncts to profitable sheep feeding.

For growing sheep per head and day, the standard varies from 5 to 6 months to 15 to 20 months as follows:

	Live weight.	Total organic substance	Protein.	Carbohydrates.	Fat.	Total nutritive substance	Ratio :1—
	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.	
5 to 6 months	56.	1.60	0 18	0.87	.045	1.095	5.5
15 to 20 months	85.	1.90	0.12	0.88	.025	1.047	8.0

A fairly balanced ration for the first consists of one pound each of wheat bran and red-clover hay, while one pound of the same hay and one of corn meal is almost as near the standard for the older sheep.

	Protein.	Carbohydrates.	Fat.	Total nutritive substance.	Ratio 1 :—
1 Pound bran	.119	.368	.028		
1 Pound red clover hay	.061	.360	.010		
	.181	.728	.038	.948	4.5
1 Pound corn meal	.053	.591	.010		
1 Pound red clover hay	.061	.360	.036		
	.114	.951	.046	1.113	9.3

An average of these two rations is more nearly balanced for a 75-pound sheep than either of these is for the younger or older sheep. The first ration above can be improved by using 12 ounces of bran and 6 ounces of corn meal instead of the pound of bran, while in the latter 12 ounces of corn meal and 4 ounces of bran will reduce it very near to the standard.

Rations fed to Swine.

1. Ship stuff and buttermilk.
2. Corn and meal and bran.
3. Corn, clover in summer, potatoes, slop, etc.
4. Corn and grass. Six lbs. corn, at $15 ton, per day and head.
5. Corn and rye meal.
6. Corn.
7. Corn, 4 lbs., peas, 4 lbs.
8. Corn, 7 lbs. at $22.50 ton.
9. Suckling sows fed all they will eat of a mixture of corn, 3 bushels; oats, 1 bushel; wheat bran, 1 bushel. Fattening swine 16 to 30 ears corn per day then soured meal. A lot of 14 two months-old pigs are being fed 1 gallon cooked cowpeas, 1 gallon bran and 6 ears corn. They have the run of a clover and lucerne patch when the weather is suitable.
11. Corn.
12. Corn, peas, sweet and Irish potatoes, turnips, bran and slop.
14. Crushed corn and cobs, corn, potatoes and meal cooked. All the corn they will eat when fattening.
15. Mostly corn, with some bran and meal.
16. Corn and potatoes, but mostly slop.
17. Bran, milk, and clover.
18. Corn and sweet potatoes.
19. Corn, vegetables and fruit.

The pig consumes a wide range of foods and is capable of converting them into meat very rapidly. Many rations can be converted into growth so fast that it may often be impossible to convince a feeder that his combinations can be so improved that his pigs will make more profitable growth. The new ration may also be better balanced and it may be so chosen as to cost less pound for pound or for a pound of gain produced from it, than before.

It is customary to keep sour food for pigs, under the impression that the souring is a great aid to a pig's digestion. Slightly soured food may in some cases show equal or even greater gains than fresh or unsoured, but the sour swill-barrel is very apt to become filthy enough to be a standing menace, even if it does not cause indigestion and disease. Sound, freshly prepared food is the best for the pig. Whether the grain food should be fed dry, or moistened, is a question upon which there is quite an accumulation of data on both sides. A pig can undoubtedly be induced to eat more moistened food, and therefore gain more for a time than if fed dry food and water in separate vessels. Yet, sooner or later, the pig so fed can be surpassed by his dry-fed brother in net result. For a short fattening period, therefore, it may be best to moisten the food and induce the pig to eat as much as possible and crowd his digestive powers for greatest net returns.

Many of the above rations are capable of, and are being put together rationally, to produce good results. Perhaps they are not

"balanced," but some of them could scarcely miss it at times. Ship stuff and buttermilk in ration 1, corn and bran in No. 2, and corn and clover in ration 3, may balance well, as also the latter ration if peas are fed with potatoes and slop. Corn and grass, corn and rye, rations 4 and 5, corn and peas in No. 7, and especially those of No. 9, are in the right direction. Numbers 12, 15, and 17 are good rations, and the only question about them is in regard to proportions of nitrogenous to carbonaceous foods which are used. In order to balance corn, potatoes, vegetables, and roots or fruit, there is hardly anything equal to peas boiled or ground, or even fed raw and whole, if pigs will eat them well.

Looking at ration No. 1 again, it is seen to be too wide in ratio and ill proportioned if fed in equal weights, as follows:

	Total dry matter.	Protein.	Carbohydrates.	Fat.	Nutritive substance.
2 lbs. corn meal	1.688	.168	1.293	.072	
2 lbs. rye bran	1.767	.194	.949	.032	
	3.455	.362	2.242	.104	2.709

There is dry matter sufficient for a 125-lb. pig and too little protein for a 50-lb. one, while carbohydrates and nutritive substance are in excess. If change is made to 2 pounds corn and 4 of rye bran the ration is still faulty, but now add 20 pounds of buttermilk and it becomes almost exacty the "standard" for three 50-lb. pigs.

2 lbs. corn	1.688	.168	1.293	.072		
4 lbs. rye bran	3.535	.388	1.898	.064		
	5.222	.557	3.192	.1372	3.886	6.3
20 lbs. buttermilk	1.702	.610	.884	.05		
	6.924	1.167	4.076	.187	5.43	3.9

Considering No. 7, in which definite amounts are stated, this ration is seen to be very well balanced for 100-pound pigs, and should be enough according to the standard for two pigs of that weight.

Corn, 4 lbs	3.376	.336	2.586	.144		
Peas, 4 lbs	3.099	.731	2.265	.028		
	6.475	1.067	4.852	.173	6.092	5.0

Thus every feeder may, by care in weighing foods and pigs occasionally, and by using the tables in this bulletin, adjust the rations fed to pigs of all sizes as well as to sheep, cows, work or fattening cattle and growing stock of all kind, so as to get the most effect from the food consumed.

V. COMMENTS OF PRACTICAL BREEDERS AND FEEDERS.

From Elias Carr, Jr., Old Sparta, Edgecombe County. Silage is made of corn and peavines. It is fed to cows, hogs, sheep, and mules. Hogs are fed on "anything and everything about the farm that otherwise would go to waste, and fatten principally on peanuts left in the ground after harvest."

T. B. Parker, Goldsboro, Wayne County, makes silage of "corn and cow-pea vines, with crab grass mixed in," and feeds it to cattle and horses.

W. L. Kennedy, Falling Creek, Lenoir County, whose colts are becoming so well known as to point him out as a successful breeder and feeder, says: I raise my own feed, and have never used ensilage. His ration for horses is: Corn, 5 lbs.; oats, 4 lbs.; bran, 2 lbs.; hay, 15 lbs. For mules, corn and fodder. But it is his ration for colts the horsemen wish to know. It is bran, 2; oats, 8; hay, 10 pounds. Mr. Kennedy's ration for cows might also be a model for very many dairymen. It is peavine hay, 30; corn meal, 8; and bran, 2 pounds.

Thomas A. Cox, Cullowhee, Jackson County, feeds grade Holstein-Friesian cows, 2 lbs. cotton-seed meal; 4 lbs. wheat bran; 6 lbs. corn and cob meal per cow of 900 pounds weight, with hay; oat straw, or corn stalks with fodder and shucks (stover). All the coarse food the cows will eat is allowed. Some of the time, wheat bran is replaced by a mixture of rye, oats, and cowpeas grown at home, as is all the feed except bran and cotton seed meal. Larger or smaller animals are fed more or less grain in proportion to weight. Other neat stock fed same ration in proportion to size. Pigs are grown on clover pasture, slops, skim-milk and corn, and fattened on mast, which some years is very abundant. Mr. Cox hopes to be prepared for silage this year.

Jas. M. Wright, Fairly's, Richmond County, feeds to cows: hay, corn, fodder and shucks, cotton seed, cotton-seed hulls, and meal and peavine hay. Never saw but one silo and have the very poorest opinion of such an arrangement to save feed for animals. If water is plentiful rather have dry feed. Our people do not invest in silos." [Doubtless on better acquaintance, Mr. Wright would have a higher opinion of the silo.]

J. R. Moore, Shelby, Cleveland County, feeds Angora goats in rough weather, some cotton seed, a little meal, and some fodder. He uses plenty of salt. For pigs and breeding sows, one part each bran, ground oats, and shorts. Places plenty of charcoal where they can get it. When pigs are fed *ad libitum* in this way they will gain one and a half to two pounds per day. Occasionally a mess of well charred corn is given them.

W. W. Boyce, Pineville, Mecklenburg County, after giving some details as to bundles of fodder, ears of corn, and gallons for the units, says: "We really have no system of feeding I wish I could get out of the old haphazard ways." He has only to weigh a few ears or bundles of fodder several times to get near the average weight of them; then by adopting a given number of bundles or ears, or quarts to represent so much weight, apply the method of balancing a ration, and when he has arrived at a satisfactory point as regards the relation of one class of nutrients in proporton to the other, present the ration to the animals in as near those proportions as pos-

sible. This should help him harmonize the "old haphazard way" of keeping the horse, cow, sheep, or pig in good condition, with the more exact one of trying to do so at the least expense or waste of food.

R. O. Patterson, Governor's Island, Swain County, observes that his cattle "do much better housed in comfortable barns than others on more feed including a lot of grain, but without shelter." There is a great deal in this observation, and on many a farm, especially in western North Carolina, where the climate is colder, the saving in food, and the gain from better condition of stock, would well repay a moderate outlay for comfortable quarters during winter.

From Baron E. d'Alinge, manager of the agriculture department of the Biltmore estate, Biltmore, Buncombe County, some valuable notes on soiling and feeding the year round have been received. For horses, 10 to 12 pounds of hay cut up with straw is fed with 8 lbs. corn, ground; 2 qts. oats, ground, and 3 lbs. bran. Mules are fed 10 to 12 lbs. hay cut up with straw, and 8 to 10 lbs. ground corn, 3 lbs. bran, and 1 lb. cotton-seed meal. If many feeders would note this use of cotton-seed meal and replace some of the corn or hay fed to working horses, mules and steers, better results would be realized from the feeding.

It is of interest to give other facts in regard to the stock and feeding at the Biltmore estate. Of the 128 cows kept for dairy use and for sale, twelve are full blooded Jerseys, and the rest are high grades. There are 58 heifers, 20 heifer calves and 12 steer calves. Of sheep 200 grade Southdowns are kept, and 70 Berkshire swine. Of horses there are 16 grade Percheron, 91 mules and 32 riding and driving horses. The stock are not grazed at all. Corn, oats, bran, cotton-seed meal, hay, oats and wheat-straw are fed. The soiling crops are crimson clover, rye, oats, peas, millet, broadcast sorghum, fodder corn, millo-maize, teosinte, etc. These are given in the order named, beginning with the end of March and ending in November. Corn when not raised on the farm, costs 58 to 62 cents per bushel, and oats 45 cents per bushel, wheat bran $18 per ton, and cotton-seed meal $22 per ton. Silage is fed to steers and cows, and corn, teosinte, cowpeas, millet and crimson clover, are used as silage crops. Corn, peas, millet, teosinte and cowpea-vines, are put into the silo in alternate layers. The common and favorite ration with silage is 35 to 40 lbs. of silage with 3 lbs. corn meal, 3 lbs. bran and 1 lb. cotton-seed meal. Will never stop using the silo and ensilage.

A year's fare of the Biltmore cows may, then, be taken from the following rations and the above soiling crops: "Ensilage, at two feeds, 40 lbs.; cut corn fodder, 4 lbs., one feed; ground corn, 3 lbs.; bran, 4 lbs., and cotton-seed meal, 1 lb.; varying for individuals according to capacity of digestion and yield."

Soiling crops follow in succession as given above, accompanied with more or less grain adapted to supplement the crop to produce a ration adequate to the demand of each animal. Between soiling and ensilage, mangold-wurtzels and sugar beets are fed.

Dr. L. L. Staton, of Tarboro, makes silage of corn and cowpea-vines. He feeds to cows of this silage, 15 lbs. with 3 lbs. cotton-seed meal, and supplies in addition all the cotton-seed hulls they will eat.

J. W. McGregor, Lilesville, Anson County, says: "We have given very little attention to raising stock here, as ours has been a cotton-raising section. But since cotton has fallen in price below the cost of production, much interest is now being given to this branch of industry, especially to hogs and horses and mules, and a great improvement is noticeable in this particular. We can raise all the grain and stock we need if the attention we have hitherto given to cotton raising is accorded to stock."

H. S. Harrison, Medoc, Halifax County, says: "Corn, oats, clover hay, ensilage and roots are used as cattle foods. We buy none, but grow them all at home. We have been using silage for quite a while, growing corn and pea-vines for it principally, and have fed both horses and cows on it with good results."*

Capt. B. P. Williamson, Raleigh, Wake County, who is doing so much to arouse interest in the best strains of American horses, says: "I produce all my hay and oats, but buy wheat bran. Hay can be produced in North Carolina for $8 per ton and oats for *one cent* per pound. Bran $15 per ton. I believe we can breed and raise *fine horses*, as fine and of as good size and as cheaply as can be done in *any State*, if we will go at it intelligently." His ration for idle (?) horses is, 8 pounds oats or bran, and 6 pounds hay. For colts 4 pounds oats or bran, and 4 pounds hay. His hay is clover and orchard grass, red top, and crab grass.

Messrs. Holt & Homewood, Burlington, breed Devon, Ayrshire, and Dutch Belted cattle, Cotswold, Shropshire and Southdown sheep and Clydesdale horses, and *sell hay at $20 per ton.* No cattle food is purchased. Horses are fed cut feed and 10 lbs. hay, at night 4 qts. meal on the feed. This meal is corn, oats, and wheat ground together; 10 to 20 ears corn at a feed morning and noon. Colts about half as much as horses. A full ration per cow is 1 peck oat and wheat meal, 1 bundle fodder (stover), 12 lbs. hay, 6 lbs. chaff and a peck of beets. Heifers $\frac{1}{2}$ to $\frac{2}{3}$ of a cow ration; bulls, 1 bundle fodder, 12 lbs. hay, 6 lbs. oat straw. Sheep run in pasture the year round and are fed oats when needed.

Dr. W. R. Capehart, Avoca, Bertie County, has fed corn silage ten years and feeds it to all teams when not at work. Rations for cows: silage, cotton-seed meal, and peanut vines; for beeves, silage and meal.

E. S. Saunders, Fayetteville, Cumberland County, in answer to "What feeds do you give sheep?" says: "Cannot say until we have a dog killing here. The dogs killed 13 sheep for me in one night. Then I sold out and quit the business."

---

*Mr. C. W. Garrett built upon this farm in 1879, and used with success the first silo ever constructed in North Carolina.

John Wilson, Coleraine, Bertie County, has kept about 75 Cotswold sheep. He says: "Have lost 50 ewes and, including their lambs, at least 100 head by dogs since last spring. Have only 24 head, now running on rye."

Messrs. Hackburn & Willet, Newbern, Craven County, report 100 Holstein-Friesian and 45 Jersey cows kept for milk. These cows are fed "about one bushel of corn silage twice a day and about 7 pounds of dry hay once a day." Dry cattle are self-supporting about 8 months. Rye and crimson clover are sown for winter pasture. About 50 horses and mules are kept. The mules at hard work are fed all the hay and corn they will eat. Horses are fed 12 lbs. hay and 12 qts. oats, or 8 to 12 qts. corn. Colts are fed mostly upon wheat bran and nice timothy hay in winter. Fattening stock are fed cotton-seed meal, hominy, and bran. Sheep are not profitable. Swine are fed on clover pasture and hominy when fattening.

W. A. Austin, Gibraltar, Union County, writing as to the use of silage, says: "I have not used it. I prefer grazing my stock during winter on green clover, rye and oats, to any silo-preserved food both for economy and nutriment. It is an easy matter to have plenty during winter to nourish stock on the farm without the silo since our climate is mild."

One other adverse criticism has been given on another food. E. W. Thompson, Macon, Warren County, says: "I think cotton-seed hulls are nearly worthless. I have tried them two years and think shucks are worth nearly double as much as the hulls." These hulls cost Mr. Thompson too much. It would be well to remember that they are like coarse wheat straw, or shucks in that they act as a mechanical filler and yet supply considerable amounts of carbohydrates only when they are well cleaned. They should be fed with comparatively large amounts of cotton-seed meal in order to realize much from them. See bulletin 93 for rations of hulls and meal.

These replies to queries have been extracted to show that the leading stock farmers in various special lines are feeding well, and that many model rations have been given. We are under obligations for the example and wise words of encouragement and counsel given. The replies given are but a few of those already received, but they are sufficient at present to encourage others, and especially beginners, and to show that obstacles can be overcome and fine stock raised here at low cost. This bulletin is issued for the purpose of calling attention to the rational principles underlying the subject of feeding animals; and, with the plain directions heretofore given, to help those who are feeling their way along, to take a better hold of the subject.

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Flowering Bulbs in North Carolina

AND THEIR

Propagation for Florists' Use

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C.

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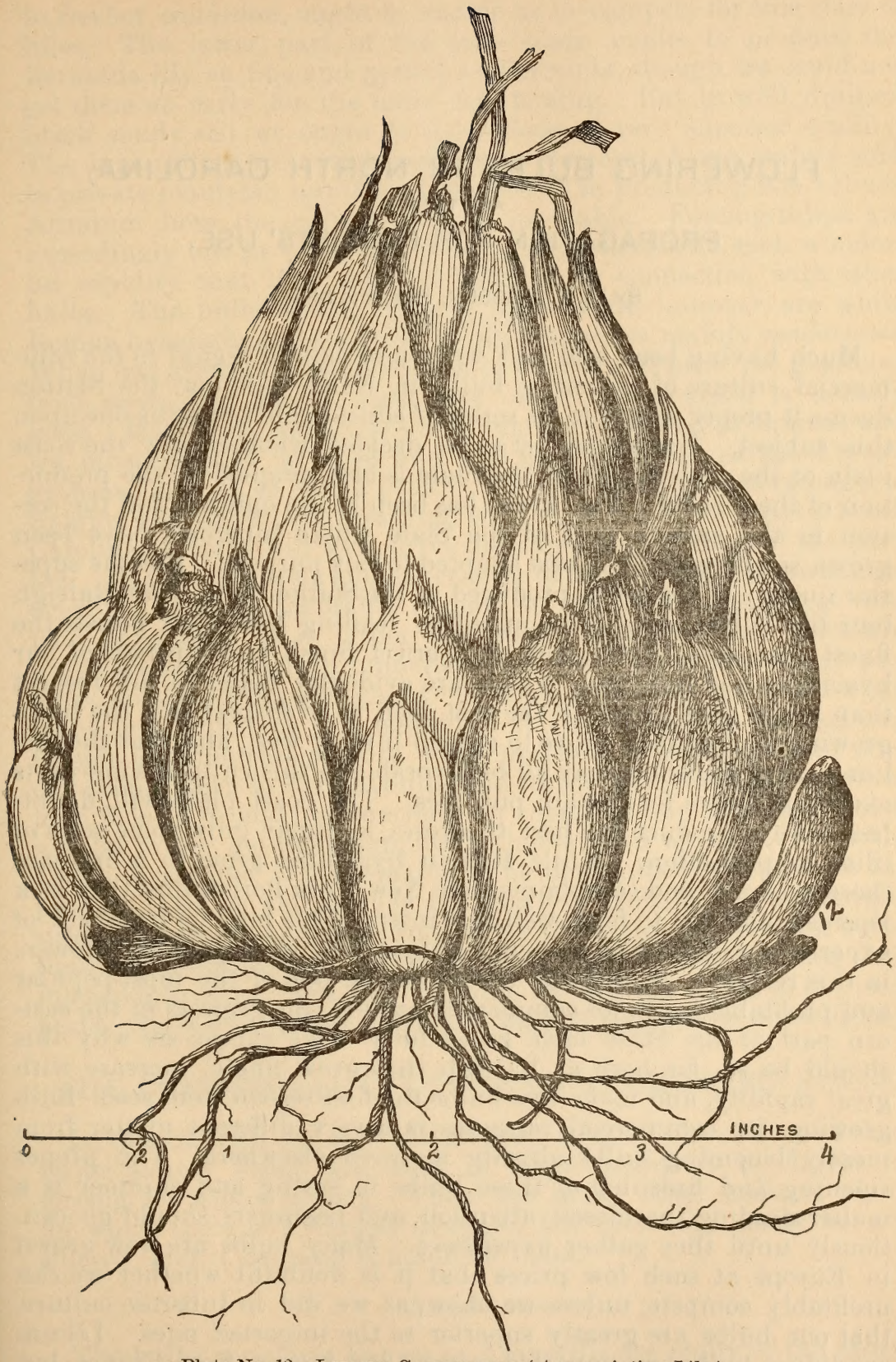


Plate No. 12. LILIUM CANDIDUM.—(*Annunciation Lily,*)
Exact size; drawn from nature.

FLOWERING BULBS IN NORTH CAROLINA,

AND THEIR

PROPAGATION FOR FLORISTS' USE.

By W. F. MASSEY, Horticulturist.

Much having been said and written of late in regard to the commercial culture of flowering bulbs in North Carolina, the Station deems it proper to add to its series of educational bulletins one upon this subject. It remains yet to be decided whether only the coast plain or the central belt of the State is best adapted to the production of these bulbs. The writer has been of the opinion that the section in the eastern part of the State where tuberoses have been grown so successfully is best adapted to this purpose. But the superior quality of the bulbs produced at the Station farm, near Raleigh (our lily bulbs being pronounced by leading New York florists the finest ever seen there), and the perfect finish and ripeness of our hyacinths and narcissus, which are evidently better in this respect than larger ones grown in the east, lead us to suspect that the bulb-growing district may prove to extend further west, and that the section east of Hillsboro may all be favorable to this culture, some parts excelling others for certain purposes. The coast plain will, doubtless, always produce the best tuberoses, and may grow some sorts of lilies to perfection. While Roman hyacinths grow to a fine size there, we have had complaints from New York florists that they lack ripeness, and fail to force well in winter. This may be from lack of experience in handling and curing them, and we hope to aid growers in this respect. As regards the gladiolus, one of the most popular and profitable bulbs for commercial culture, the growers in the eastern part of the State have failed fully. We cannot see why this should be so, for here at Raleigh they grow finely, increase with great rapidity, and make fine bulbs the first season from seed. Bulb growing for commercial purposes is a very different matter from merely blooming bulbs already matured elsewhere. The proper ripening and finishing of these bulbs in spring and summer is a matter needing the closest attention, and beginners should go cautiously until they gather experience. Many bulbs are now grown in Europe at such low prices that it is doubtful whether we can profitably compete, unless we show, as we did in tuberose culture, that our bulbs are greatly superior to the imported ones. Lilium candidum bulbs are imported at very low figures from France, but with the extra quality of our bulbs, aided by the expense of importation, and the fact that our bulbs can be laid down in New York

in fresher condition, ought to enable us to compete for this class of lilies. The lower part of the coast plain ought to produce the Bermuda lily as fine and perfect as Bermuda, though we could not get them as early for the early fall forcing. But in well drained black sandy soil we ought to grow these of very superior quality. The Japan lilies are not in such heavy demand, being mainly sold to private planters; but if we can succeed in producing fine Lilium Auratum here the culture will be profitable. Forcing-tulips are exceedingly low in price, but they increase here with such wonderful rapidity that they may be handled in connection with other bulbs. The bulbs which promise most profit, however, are white Roman hyacinths and gladiolus of various species, mainly *gandavensis*. When our growers once learn how to handle and grow the gladiolus from seeds, and named sorts from offsets, the demand is usually good. Roman hyacinths are now mainly produced in France, and we must produce as good and well finished bulbs as the French growers, and at as low a price. We will have the advantage of freights and import charges, and, with experience, we believe North Carolina Romans will soon drive the imported bulbs out of the market. But it takes time and experience to learn to grow these things, even in our more favorable climate, to equal the products of men who have been at it, father and son, for generations. Narcissus bulbs are now grown in numerous varieties. These are largely produced in the south of England. Some species need particular treatment here, which we will mention. All can be grown to great perfection, and increase rapidly when properly handled. When once our people learn to handle bulbs and finish them well, there will be no difficulty in making contracts for them, for our Northern florists had far rather get their supplies at home than abroad. As to the Dutch hyacinths, it yet remains to be determined whether we can produce them as well as they are grown in Holland. They require special treatment and handling, which the Dutch understand better than any other people. Several Dutch growers have signified their intention to come here and examine for themselves as to the prospects. In the meantime we should handle Dutch hyacinths lightly.

THE COMMERCIAL CULTURE OF FLOWERING BULBS.

In this bulletin we will endeavor to treat of the culture of those bulbs mainly which are used in large quantities by florists for forcing for winter flowers. There are many other bulbous plants for which there is a limited demand, but these can easily be considered later if demand is made for them.

AMARYLLIS.

The bulbs popularly known as Amaryllis are really of the *Hippeastrum* genus of *Amaryllidaceæ*. They are generally hardy here, but as their growth is made in summer, they should always be lifted

in fall, when grown for sale. They are increased both by seeds and by offsets. To keep a variety pure it must be grown from offsets. Seeds produce flowers of many shades, and new ones of value are grown in this way. Hippeastrum bulbs are always quoted at high prices in the catalogues, but the demand for them is not large. Fresh seeds are hard to get, and they must be sown as soon as ripe, for they soon lose vitality, being rather a little bulblet than a seed in appearance. They should be sown in a cold frame in early spring, under the protection of glass sashes, and should be kept growing strongly all summer. In fall the sashes should be on as cold weather begins, and the frames kept as dry as possible, and well covered with leaves or straw in cold spells to exclude frost. By the next autumn the bulbs will be of blooming size. Shading with lath screens in summer is a great help, and they should never be allowed to lack moisture when in active growth. A strong clay soil suits them best. Hippeastrums are slow to recover from loss of their roots, and these should always be kept good, and in separating offsets from main bulb always separate the roots carefully. They can be better grown in a greenhouse in pots, but more cheaply in the way here mentioned. Most of them being evergreen, no attempt should be made to cure out and dry the tops. The time for ripening is in late summer, and potting and replanting should be done at once. When grown in pots they bloom early in the greenhouse, and after blooming should be encouraged to make a good growth and then gradually ripen. The pots are then plunged in the open ground in a rather shaded place, but not under trees, and take their chances until fall, when they are returned to the greenhouse and kept rather dormant, until the flower stems push towards spring.

FREESIAS.—(*See plate No. 19, p. 342.*)

These are a class of small bulbs now largely grown in cool greenhouses for winter flowers. An immense number can be grown in a limited space. They should always be grown here in cold frames, covered with glass sashes, as their growth is made in the cool weather of late winter and early spring. Though almost hardy, they will not endure freezing when in growth. One of our tuberose growers in Eastern North Carolina planted a large lot last spring in the open ground in February. They grew off splendidly, and the warm and frostless weather of the greater part of March put them into rank growth. Then came the sudden unprecedented freeze of March 26, and the whole lot was destroyed. Had they been in frames, and the glass well covered with straw, they would have been safe. The bulbs are very small, and, in planting for increase, should be dribbled in in the frames two inches apart each way about February 1st. Keep the glass off in all good sunny weather, and avoid getting them into too sappy growth, but stand ready to put on the glass and cover to exclude frost or any sudden change. It will be rare that

such a sudden and severe reverse comes so late as the freeze of March last, but the grower should be ready for it. The frames should be banked with earth on outside. The bulbs sell at low prices, but as a single 3x6 foot sash will produce a thousand easily, they can be made to pay. *Freesia Refracta alba* is the sort generally used. This is pure white, while the species *F. Refracta* has a yellow spot in the flower. It is hard to find an unmixed lot however.

GALTONIA CANDICANS.—*Hyacinthus Candicans.*

Cape hyacinth is a South African summer-blooming bulb allied to hyacinths. The bulbs grow very large, and produce spikes of white bell-shaped flowers three to four feet tall. They are very easily grown from seed sown in the open ground early in spring (February or March), and in light, sandy soil made rich they will make fine flowering bulbs here the first season. Writers advise private growers to dig up and throw away the bulbs after once flowering, saying that they are then worthless. But this is not the case here. Bulbs planted in our grounds last year bloomed well and were left undisturbed in the ground all winter. This summer they made great clumps of massive foliage, and made ten spikes of flowers to the clump, one set blooming in June and July and the second in August. There is not a large demand for the bulbs, as they are not used by florists. They are grown as easily as onions, and are perfectly hardy.

GLADIOLUS.—(*See Plate No. 22, p. 343.*)

The Gladiolus, or Sword Lily, is one of the most important bulbs for the commercial bulb-grower. They are sold in great quantities, and American bulbs, or rather corms, for they are not true bulbs, are exported abroad. All of them survive our usual winters here, but this is a matter of no importance to the commercial grower, since they must be lifted and cured in the fall. There are many species of the gladiolus genus, but the one mainly grown for sale is a hybrid known as Gandavensis, having been produced at Ghent, or Gand, in Belgium. In speaking here of gladiolus, it is to this variety we refer. They comprise a wide range of colors, from nearly pure white to the deepest crimson. There are many named varieties, and to keep these true they must be increased from the small corms, or offsets. The new corm in a flowering plant grows right on top of the old one, and around and under its base a multitude of minute bulblets or small corms are produced. These are to be sown pretty much as the seed are, but deeper. From seed we usually get a great variety of colors, and the large bulk of the bulbs on the market are produced in this way. The seed may be sown either in fall or spring; we are inclined to prefer late February or early March. The soil should be level, light and rich, and should be deeply and well prepared as for sowing onion seed. Sow rather thickly, and cover with

light soil, sifted leaf-mold best. Then cover the entire soil with pine straw, to prevent drying or crusting. When well up take off the straw, and thereafter never allow the soil to crust, but work well and rapidly. When started thus early nearly every bulb will, in this latitude, grow to a blooming size the first season; but most of them, though large enough to make flowers, will make more saleable bulbs by planting another summer. They are kept in a dry, cool—but not frosty—place during the winter, and set out again in March; they should then be planted not less than four inches deep. An immense number of bulbs can be grown on a small piece of land the first season. The second season they should be set in rows like onion sets, and cultivated by horse-power. Some varieties produce a multitude of offsets, others very few. Unless growing some special named sorts, it is always better to grow from seeds, as the saleable bulbs are gotten just as quickly. One great advantage we have here in growing gladiolus seedlings is that our rainy season usually comes in July and August, and the bulbs develop much more than they do northward, where they are apt to have dry weather at that time. With plentiful moisture and heat they grow very rapidly, and do not show the inclination to ripen off in August, as is noticeable northward. The points to observe in growing gladiolus seed are: first, light, rich, level soil; second, early sowing and protection of the land from crusting; third, rapid and clean culture.

Hyacinths, Roman.—(*See plates 2 and 4, p. 338.*)

We will not treat here of the large flowering or Dutch hyacinths, which are imported so largely annually from Holland, because it is yet to be determined whether these can be grown here to compete with those from Holland, where for generations the culture has been practiced to such an extent that the markets of all other countries are supplied with the Dutch product. Their production requires an amount of time, skill, and patience, which few other people are willing to undertake. The Roman hyacinth, particularly the white Roman, is the variety largely grown for winter forcing for cut flowers by florists, for which its delicate and graceful sprays so well fit it. It can be had too in bloom earlier than the Dutch hyacinths. This species of hyacinth blooms here in the open ground almost invariably from 20th to 25th of December, and continues to throw up spikes from the same bulb all winter. The flowers here are often damaged by frost when in bloom, but if planted in a frame and protected by sash the flowers can be cut in perfection all winter. The bulbs propagate more rapidly by natural offsets than the Dutch hyacinths do, but they can be made to produce offsets in the same way in which the Dutch treat their bulbs. This is by cutting gashes across the base of the bulbs, when first dug, extending half way the depth of the bulb, and then leaving them in a trench for awhile covered with soil, then take them out and dry. By time for planting in autumn

a large number of bulblets will have formed. These are planted without detaching from the parent bulb and grown thus one season. The next spring they are dug, and cured in trench and dried as before, and the bulbs are then separated and planted for the crop. The Roman hyacinths now used in this country are all imported from France, but we have grown as fine bulbs, or finer, in Eastern Maryland as we ever saw imported. Experiments made by the Northern florists in having Roman hyacinths grown in Eastern North Carolina have been in some cases unfavorable. The bulbs, they say, were extra large and showy, but in forcing they exuded gum and rotted at the heart. Now we feel that this may be the fault of the grower, and not of the soil or climate, for we have grown as perfect and good flowering bulbs here as could be desired. The fault, we think, was in the curing. These bulbs make a fine mass of foliage after the bloom is past, and should be kept green and growing until the leaves turn yellow. Then chop off the leaves at the surface, lift the bulbs and scatter them in a trench and cover with soil to cure. Letting them lie in the sun to cure like onions will not do. After lying three weeks in the trench, or, what we think is better, in a row on the surface covered with a ridge of soil, take them up and dry well on shelves in an airy room. Clean and ship in August. Treated in this way, the bulbs will be solid and have no tendency to gum. If the leaves are left to get perfectly dead and decay while attached to the bulb in the ground they will surely gum. Another way in which we have cured them is to dig with the partially ripe leaves still attached and lay in winrows in a shady place for a week or more, but the first plan is far better. The curing is the main point. We can grow larger bulbs than the French can, and if we finish them as perfectly there will be no difficulty in selling them by the million. The flower spikes should be cut off as fast as they get into bloom so as to throw all the strength into the bulbs.

When the Dutch hyacinths come to be handled here as the Dutchmen grow them in Holland it is probable that our upland sandy soils will be found capable of producing even finer bulbs than are grown in Holland. It requires from three to five years to grow a crop of these to marketable size, and they are grown in Holland profitably on land worth thousands of dollars per acre, but it will take time and large experience to develop their culture here. This Station will undertake the work, and at proper time will give the results.

Lilies.—(*See Plate 12, p. 323.*)

In common parlance the name Lily is applied to many plants which are in no way related to true lilies. The common *Richardia Ethiopica*, or calla lily, is not a lily at all, but an arum. The lilies have bulbs made up of thick scales imbricated over each other. There are many species of this genus, all of which are hardy in this climate. To propagate lilies we carefully strip off the scales down to

the stem on which they grow. These scales are planted thickly in an upright position in a shallow box of light soil in a greenhouse. The time for planting the scales will vary with different species, since they vary in habit of growth. *Lilium candidum* ripens its foliage here in June, and makes a fall growth which remains green all winter. It then must be planted, while dormant, in June or July. The boxes are kept in a cool greenhouse, and will form small bulblets from the dormant buds at base of scales. The next June, when the leaves ripen off, these bulblets are planted in the open ground. Many of these will grow by the following summer to a size that will give blooms the following year, but for large bulbs must be grown another season. Lilies also increase naturally by bulblets formed above the old bulb and around it. Some species increase rapidly by bulblets which form in the axils of the leaves above ground. The *candidum* lily is largely used by florists for forcing under glass. The bulbs are mainly imported from France, but bulbs grown here are far superior to the French, and when produced in quantity will find ready sale. The varieties of lilies are so numerous that we cannot here enter into any description. The long white trumpet-shaped lily known as Bermuda lily is a variety of *L. longiflorum*. The bulbs are largely grown in Bermuda, and for early forcing the Bermuda bulbs will excel, but we can grow them here to great perfection, and for quality can easily compete with Bermuda.

NARCISSUS.—(*See plates* 1, 3, 5, 6, 8, 9, 10, 13, 14, 15, 16, 17, 18, 20, 21, *pp.* 338, 339, 340, 341, 342.)

There is a bewildering variety of *Narcissi* grown. All can be arranged in three general classes. 1st. The old yellow daffodils and jonquils, either single or double. 2d. The hardy white-flowered ones, of which *Narcissus Poeticus* is a type. 3d. *Polyanthus Narcissus*, which are usually considered tender, but which are hardy enough under proper treatment. This class must be planted deeply and not put in the ground early in the fall as the others are, for if so treated they grow at once and frost cuts them down; but planted here about January 1st they do exceedingly well. *Narcissi* are propagated by natural offsets which they make abundantly. It is best not to separate them, but to plant the clusters and grow until they separate naturally. The low moist lands of the eastern section will grow these to great perfection. All should be planted full five inches deep.

TUBEROSE —(*Polyanthus Tuberosa.*)

It is hardly needed that a word should be said about tuberose growing, for it is a well known fact that our growers in Eastern North Carolina excel all others in producing these bulbs. Tuberoses are increased by the offsets which they make abundantly. A bulb only blooms once and then is worthless, except for the offsets it has made.

The variety most commonly grown is the dwarf double sort, called Pearl. The tall single-flowered variety is an earlier bloomer and better for cut flowers. There is also a variety which has foliage striped with white. Twenty years ago tuberoses commanded $50 to $60 per 1,000. Now growers get about $4, we believe. Fashion in flowers has left the tuberose, and there is less demand for them. They are still fairly profitable to the extent of the demand.

Tulips.—(*See plate No. 7, p. 339.*)

Tulips are grown in endless variety for out-door bedding. But as our purpose is mainly to speak of those bulbs which are produced in large quantities for the use of commercial florists, we will speak here only of the early tulip (*Tulipa Suaveolens*) the Duc Van Thol tulip. This may be taken as a type of the class of early tulips which are now sold in immense quantities for forcing under glass for the cut-flower trade. The cut shows an under-sized bulb. But one remarkable feature of this variety seems to be the fact that almost any sized bulb will bloom. All of our offsetts, planted last fall for the increase of our stock, bloomed as well as the finest bulbs this spring. These tulips are very rapidly increased from natural offsets. All tulips are easily grown from seed, but it requires three years here to grow a flowering bulb from seed and five years in the north. Tulips are sold at very low prices, but as 250,000 to 300,000 can be produced on an acre, they pay very well to the extent of the demand. Good mellow garden soil suits them well, and the richer the better.

General Discussion.

There are a host of other bulbous and tuberous plants grown, but we have aimed only to treat of those of commercial importance when grown on a large scale. When our cultivators get skillful in producing these, the minor bulbs and tubers can easily be added as demand requires.

The article (see Appendix, p. 333) by Mr. C. L. Allen, an experienced bulb grower and importer, was published lately in the *Florists' Exchange*. Mr. Allen has long been of the opinion that the bulb industry should be built up in North Carolina. He has had the promise of an experienced Holland grower to come over and examine for himself, as soon as business affairs improve.

While there is no doubt that skilled men will yet develop a profitable business in North Carolina in producing the millions of flowering bulbs now annually imported for winter forcing, we would caution our people against rushing into a culture they do not understand. The planting of mature bulbs for ornamental purposes, and the producing of these commercially, are two entirely different matters. Bulb propagation requires special skill, and experience in handling them for market. A man disposed to invest land and

money might perhaps succeed by employing an expert, but the best plan is to go exceedingly slow and test your soil for the purpose. It remains yet to be fully proved which particular region of the State is best for bulbs. We are inclined to believe that they will be best grown on our central uplands and in the sand-hill country. The North Carolina Agricultural Experiment Station is working annually in this matter, and we hope to develop a great industry here. If we succeed in settling some experienced bulb growers here our people will not be slow in catching on. In the meantime, experiments should be on a small scale until we show the Northern dealers just what we can do.

The largest bulb importer in New York lately wrote: "I annually go to Europe to buy bulbs; it would be much easier and more pleasant to go to North Carolina, and I hope you will work up the matter and I will aid all I can." It has been demonstrated by several New York dealers that the low country of Eastern North Carolina will not grow gladiolii to compare with the uplands. Roman hyacinths there grow large, but so far, whether from bad curing or from some fault in soil, the bulbs grown there have not forced well when taken North, and it remains to be seen whether they can be profitably grown there. Both of them do excellently well at Raleigh. The eastern low country will doubtless be able to produce Narcissus and lilies in great perfection, and the higher and drier sandy lands there may grow hyacinths, when the proper skill is used in curing them.

All these bulbs are usually grown on contract for the large dealers in New York and other large Northern cities, and contracts can only be had when dealers are satisfied that the grower can produce the bulbs in good quality.

We would add for the benefit of growers in Eastern North Carolina, that we are satisfied that the only difficulty in their producing bulbs of the best quality is wet soil. The dry sandy ridges, plentiful in most of the eastern sections, will grow the finest bulbs if handled properly. Mr. C. L. Allen, who says the gladiolus will not do at Magnolia, wrote to me that they did well at Cronley. Now there is very little difference between the two places, except that much of the soil at Cronley is higher and drier than at Magnolia and Wallace. Tuberoses grow finely on black land. For other bulbs the sandy dry ridges well fertilized will be best. Experiments should be made cautiously until experience shows the best course. We will doubtless eventually bring the bulb business to North Carolina, but we do not advise our people to rush into it on a large scale until the best modes of treatment and best soils are definitely ascertained. The present bulletin is but a beginning. We will give results as fast as we get them. In the meantime we are getting importers and bulb growers abroad interested in the matter, and our earnest hope is to locate a profitable industry in North Carolina.

APPENDIX.

[Extract from *New York Florists' Exchange*, August, 1894.]

BULB CULTURE IN NORTH CAROLINA.

In a recent number of the *Florists' Exchange* (p. 655) Mr. W. F. Massey takes up the bulb-growing question again with no little vigor, seeing, as he does, a fine opportunity to add to our country's industries. In a private letter to the writer he takes up the question more in detail, and gives us some results from trials made in various parts of North Carolina. This letter we will answer openly through the medium of the *Exchange*, as neither of us have private opinions or secret wishes in regard to this matter, our only desire being to extend our industries in every direction in order to increase the wealth of our country, which can only be done by the employment of idle hands and idle lands.

That bulbs of all denominations can be profitably grown in this country does not permit question; experiment has fully established the fact. Within the writer's recollection all our tuberoses and gladiolus were imported. To-day we export annually many times more than we ever imported, and we not only grow them much cheaper, but better than they can be grown in any other country. The conditions of our soil and climate are alike favorable for rapid increase and excellent quality. What is true of the bulbs mentioned is also true of all others, and all that is required to build up the industry is to have it undertaken by competent, experienced hands.

Somewhere about 1850 the late Isaac Buchanan undertook to grow hyacinths at his nursery in Astoria, L. I. He commenced in the way that is practiced by the Dutch growers, by making incisions across the base of the bulbs for the production of bulblets or offsets; these were freely produced, and annually grown on as in Holland, until they reached their limit as to size and quality. At this period the Brooklyn Horticultural Society was at the height of its prosperity, and at their spring exhibitions large premiums were offered for the best hyacinths in bloom in pots and glasses, and at this exhibition Mr. Buchanan carried off the first prizes for blooms from his American-grown bulbs. Mr. Buchanan frequently told the writer that all that was necessary to make the growing of bulbs profitable in this country was to grow them. He showed his faith by his works in growing gladiolus and tuberoses, which he did successfully, so far as the extent of his land and the time he could spare from his well established florist business would permit.

The growing of Roman hyacinths and Lilium candidum was attempted from necessity in North Carolina, under the direction of the writer. A large consignment from France, which had been detained several weeks from an accident to the steamer, arrived in seemingly worthless condition. They were so much grown that when a case was opened the contents came out in one mass, and apparently worthless. A hospital for sick plants was sought, and found in the sand hills of North Carolina, where a clergyman, with floral proclivities, but with very limited knowledge of cultivation, undertook to grow them, and agreed to follow to the letter the instructions given, which he did under the most unfavorable circumstances. The soil could not be got in suitable condition on short notice, and intelligent labor was nowhere to be found, but the work was done, and the following season the bulbs were returned fully restored to health, and to all appearances in the best possible condition for forcing. In due time these bulbs were distributed to the florists throughout our country, and a note made of each lot in order to see what the result would be. We awaited results with no little interest, and to our surprise when the parties, who purchased these bulbs, gave their orders the following season they insisted upon having the same kind of bulbs as they had given them the previous year, as they were the best they had ever grown.

A small sample of these were sent us early in the season in order that we might know whether they would answer the purposes of sale. These were carefully examined by a Dutch merchant, who pronounced them very fine, but what astonished him most was the soil in which they were grown, which was precisely the same as that in which the best Holland bulbs are grown.

We will now hastily review Mr. Massey's letter. He says:

"I am still investigating the bulb-growing question for North Carolina. I am becoming strongly of the opinion that for the gladioli and Roman hyacinths at least the uplands will beat the low coast region. I saw a lot of Romans, grown at Wallace, a short time ago. While they are large (the best was six inches) they

look suspiciously soft at center, and I fear they will gum. This may be the fault of the inexperience of the grower in curing. Bulbs I have grown here, while not so large, are remarkably bright and solid. My best ones averaged eight spikes last winter. They were fully as large as the French. The colored Romans grown here are remarkably solid and heavy. I sent Henderson & Co. a sample of the average of our candidum lily bulbs, grown here on a high, dry hill of red clay loam, sloping south in full sun. They remark of them: 'They were grand bulbs, not only very large, but very solid and heavy. If such bulbs can be grown in North Carolina at prices to compete with the French, there would be no trouble to place orders.' I fear, however, that the imported bulbs are too cheap for us to compete. But for forcing purposes, our bulbs, dead ripe in June, ought to have a great advantage in condition for potting and getting established. I believe that our soils here will make better finished bulbs than the sandy soils. But I have a large tract of land in the upland sand-hill country in Moore County, near Aberdeen, where I propose to make an experiment with a variety of bulbs. I weighed one of my well cured Narcissus polyanthus a while ago, it weighs five ounces—a very fine bulb, I should say. I do not believe that the sandy lands will make the solidity and weight our loam soil will.

"Gladioli do remarkably well here, though in the lands along the Atlantic coast line, they do not seem to thrive. Seed that came late last spring and were sown late in April made bulbs, or corms rather, nine-tenths of which have bloomed already. Had the seed been sown in February, or in the fall, I believe all would have made, not only blooming, but good sized sale bulbs last fall. Of course with them mere size does not always indicate quality. The natural increase of six large bulbs set last year will give me next fall at least 114, if not more, of marketable bulbs. I have never seen this increase equalled. I believe our people will grow bulbs successfully yet. Those who have tried them are perfectly green at handling anything except tuberoses, and cannot, of course, be expected to produce stock equal to that grown by men who for generations have been gaining experience in the art. Have you heard anything more from the Dutchman you wrote to me about a year ago? I fear the soil and humidity of the coast plain is against it, for I learn that Romans in Bermuda have the same fault as those I noticed at Wallace."

When the growing of hyacinths at the South, as an industry, was first agitated we stated plainly the low lands of North Carolina, where the tuberose finds such a congenial home, were not adapted to the cultivation of other bulbs. There appears to be an acidity in the soil that is injurious to other bulbs. We examined the gladiolus grown at Magnolia and found the bulbs all diseased, a condition we could not attribute to any other cause than certain elements in the soil unsuited to the bulbs. The tuberose being an evergreen and a native of marshy places, thrives admirably in a soil like that of Magnolia and Wallace, where the water comes very near the surface; other bulbs will not. But there are thousands of acres of land in North Carolina that are now idle, where bulbs can be well and profitably grown.

Mr. Massey thinks the price of Roman hyacinths is so low that it will not pay to grow them. Let us look at that for a moment. In France, where these bulbs are principally grown, land is worth from $400 to $600 per acre, at least forty times as much as equally good land for bulb growing can be bought for in North Carolina. The cost in freight to get them from France is at least three times as much as to get them from North Carolina to the market where these bulbs are sold, so that if it pays to grow them in the former country, why will it not in the latter?

But let us be more explicit. To grow Roman hyacinths it requires three years to bring them to perfection, and an acre will produce, the first year's growth, 250,000; the second year, 150,000, and the last year of the bulbs' growth, 100,000. For the three years' cultivation the grower would get, at present prices in France, $600, or $200 per year. Would it not be a good paying crop at one-half that price? Compare it with cotton, corn or wheat, and arrive at your own conclusions.

To make the industry profitable in North Carolina it must be started and conducted by men who thoroughly understand it. The growers in Holland are beginning to see that this country will eventually be the one where their productions must be grown. Several of them are seriously contemplating making the start and we believe they will look over the ground another year with the view of establishing the industry.

C. L. ALLEN.

Floral Park, N. Y.

PLATES OF BULBS

GROWN IN NORTH CAROLINA AT THE EXPERIMENT STATION.

(Exact size; Drawn from Nature.)

No. 1.

Narcissus Odorus (*N. Parvi coronatæ*) Campernelle Jonquil—a golden yellow variety, bearing four to six flowers on a scape. A good sort for forcing in winter.

No. 2.

White Roman Hyacinth—the variety most generally used for forcing. Each bulb gives from three to eight spikes of white flowers. Blooms in open ground at Raleigh from December 20 to March 1.

No. 3.

Narcissus Alba Plena Odorata. Double White Poet's Narcissus. White flowers, similar to Cape Jessamine blooms.

No. 4.

Rose Colored Roman Hyacinth. Flowers similar to White Roman, but of a bright pink color. Not so much used as the white.

No. 5.

Narcissus Jonquilla—Single Jonquil. (*Narcissus Parvi coronatæ* or true Narcissus.) Flowers yellow and sweet.

No. 6.

Narcissus Tazetta (*Polyanthus Narcissus*). Double Roman. Flowers white, double, with orange cup. Profuse bloom. Fine forcing variety.

No. 7.

Early Tulip. Scarlet Duc Van Thol. Largely used for forcing.

No. 8.

Narcissus *Incomparabilis Aurantius Plenus.* Double Orange Phoenix. Eggs and Bacon. Pale sulphur color, orange center. Very fine.

No. 9.

Narcissus Golden Spur (*N. Magni coronatæ*). Large yellow trumpet Narcissus. One of the best for forcing.

No. 10.

Narcissus Poeticus. The Poet's Narcissus. Flowers white, with red cup. Late bloomer.

No. 11.

Narcissus Golden Plover. Another of the *Magni coronatæ* or large trumpet Narcissus. A fine forcing sort. Similar to No. 9.

No. 12.

Lilium Candidum. White Garden Lily, "Madonna Lily," "Annunciation Lily." This lily thrives wonderfully in North Carolina. Our bulbs average thirteen inches in circumference. These bulbs are largely used by florists for Easter forcing.

No. 13.

Narcissus Telamonius Plenus—Von Sion. This is the old Double Daffodil; known everywhere, and imported in immense quantities for forcing.

No. 14.

Narcissus Incomparabilis. The Peerless Daffodil. White and yellow.

No. 15.

Narcissus Obvallaris. The Tenby Daffodil. Large trumpet Narcissus. Flowers yellow.

No. 16.

Narcissus Leedsii. The type of a cross-bred strain of *Narcissus Media coronatæ* from *Poeticus X Cernuus.*

No. 17.

Narcissus "Stella." Another of the *Incomparabilis* group or Peerless Daffodils. Flowers white and very early.

No. 18.

Narcissus "Ard Righ"—Irish King. One of the group of large trumpet Narcissus.

No. 19.

Freesia-Refracta Alba. Freesias belong to the order *Iridaceæ.* They are hardy in this latitude if covered well or grown in frames. Bulbs small and increase rapidly.

No. 20.

Narcissus Princeps. Another large trumpet Narcissus. Rich orange color. A fine forcing bulb.

No. 21.

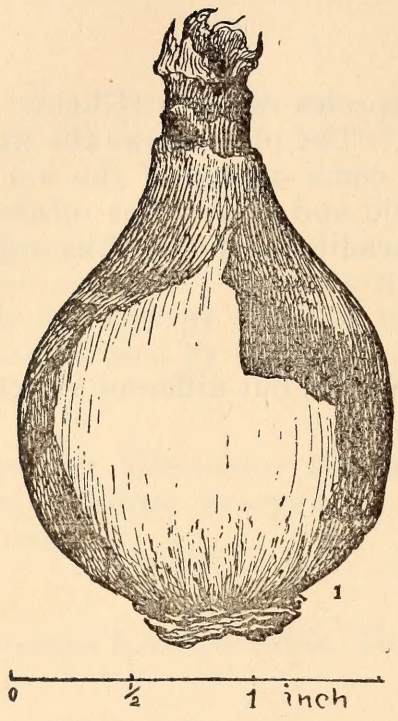
Narcissus *Scoticus* (*N. Pseudo-Narcissus*). Known in England as "Garland Lily."

No. 22.

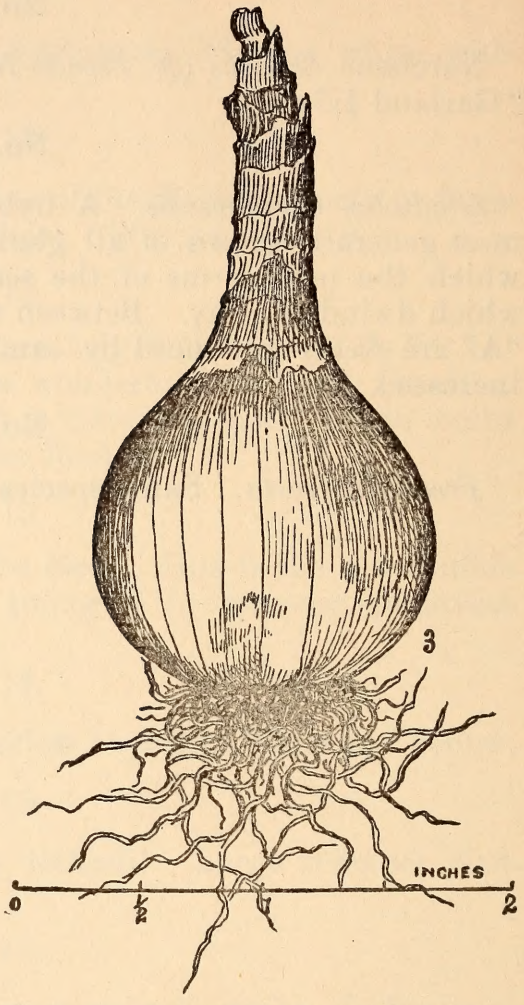
Gladiolus Gandavensis. A hybrid species raised at Ghent. The most generally grown of all gladiolis. The plate shows the way in which the new corms of the season come on top of the old one, which dwindles away. Between the old and new corms offsets like "A" are freely produced by same varieties and are thus rapidly increased.

No. 23.

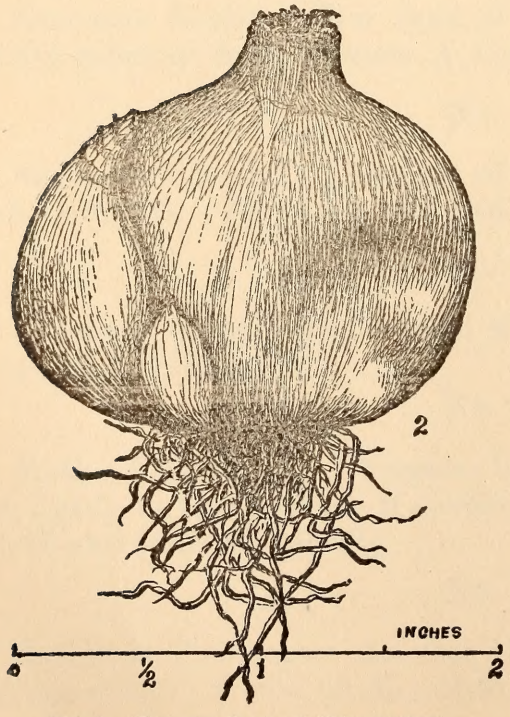
Freesia-Refracta. Same species as No. 19, but different variety.



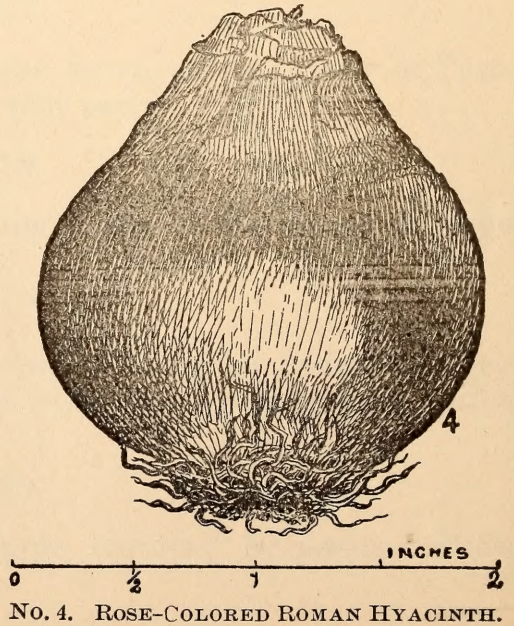
No. 1. NARCISSUS ODORUS.—(*Campernelle Jonquil.*)
Exact size; drawn from nature.



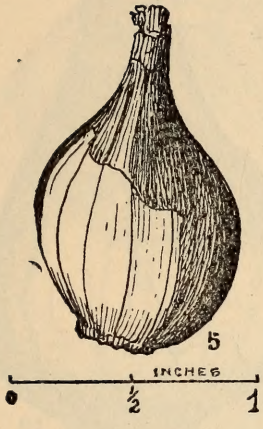
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(*Double White Poets' Narcissus.*)
Exact size; drawn from nature.



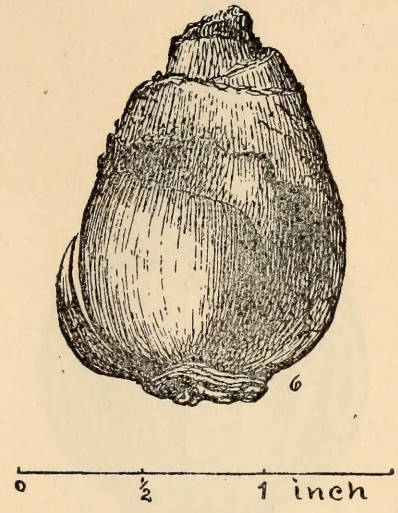
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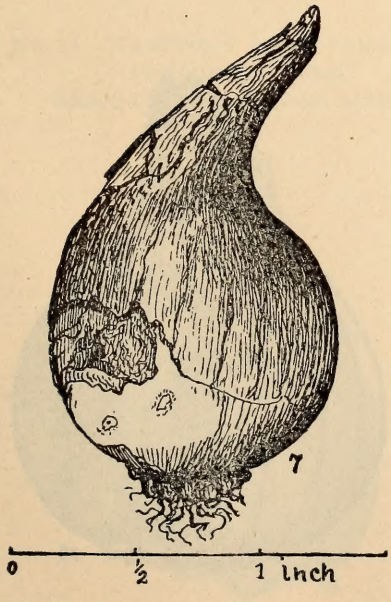
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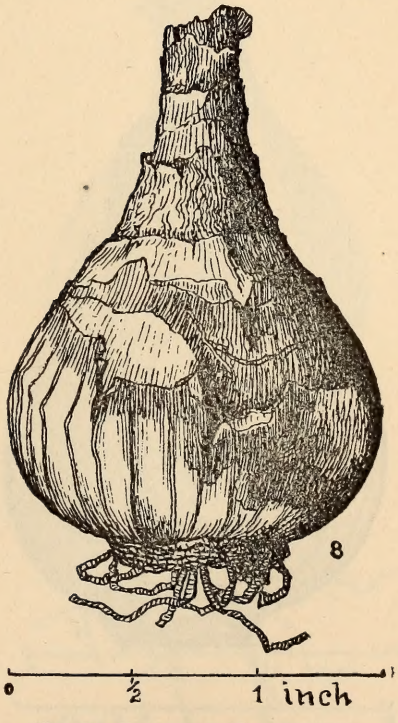
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(*Single Jonquil.*)
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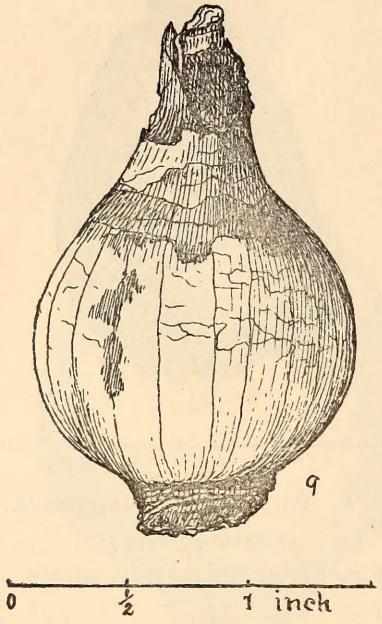
No. 6. POLYANTHUS NARCISSUS.
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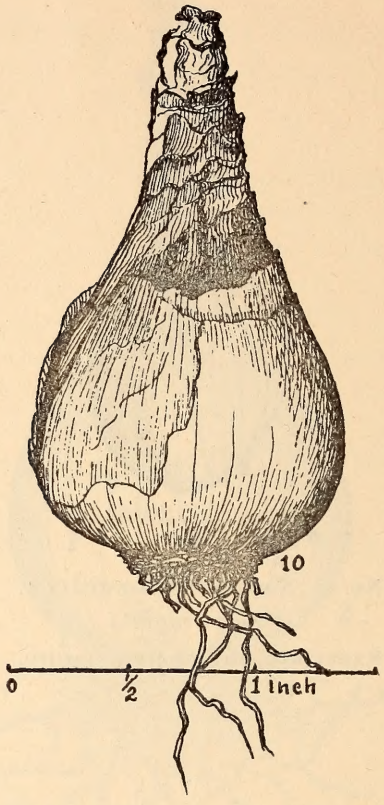
No. 7. EARLY TULIP.—(*Duc Van Thol.*)
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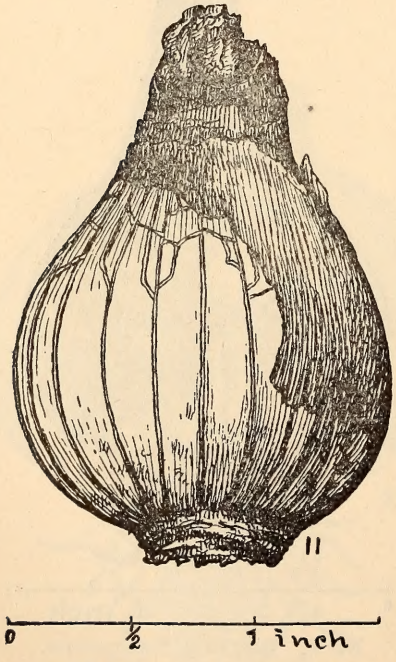
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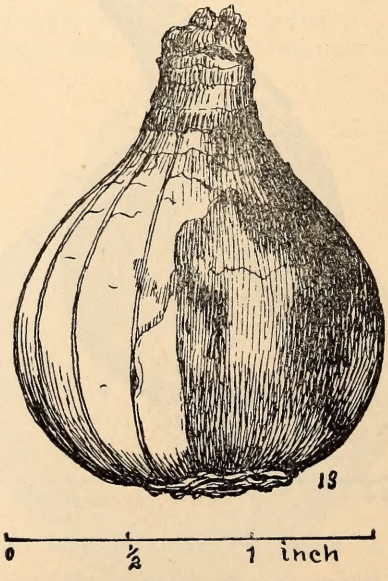
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(*Magni Coronatæ*) *Yellow Trumpet Daffodil.*
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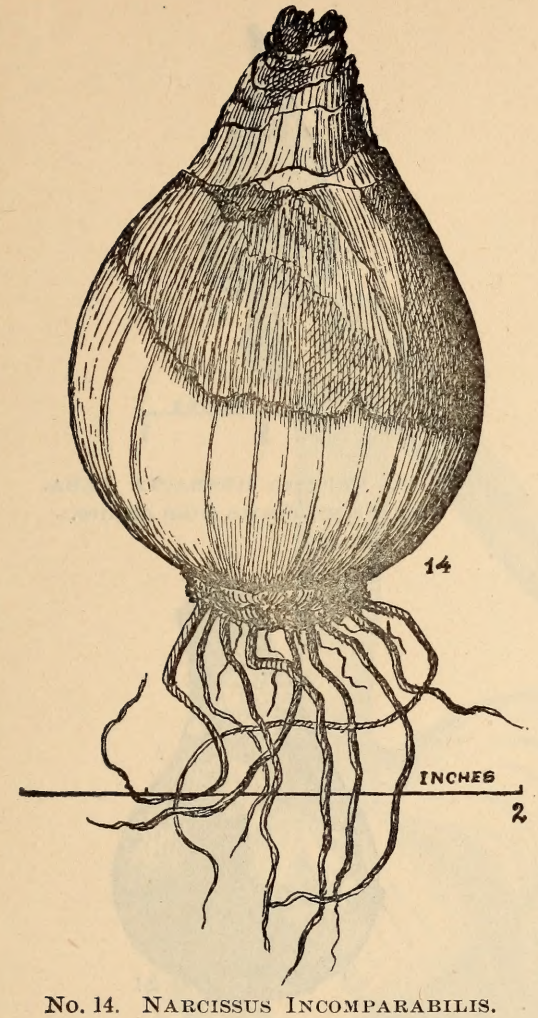
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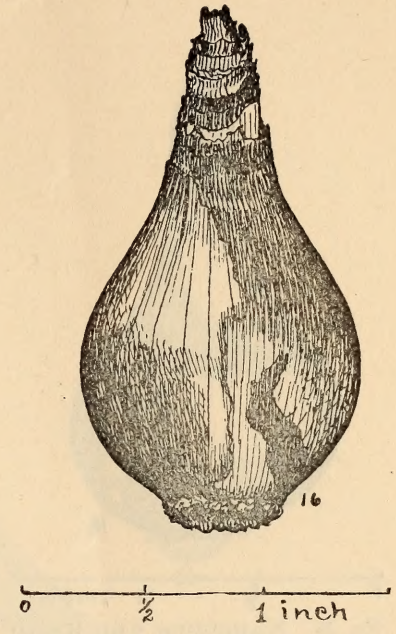
No. 11. NARCISSUS GOLDEN PLOVER.
(*N. Magni Coronatæ*) *Yellow Trumpet Daffodil.*
Exact size; drawn from nature.



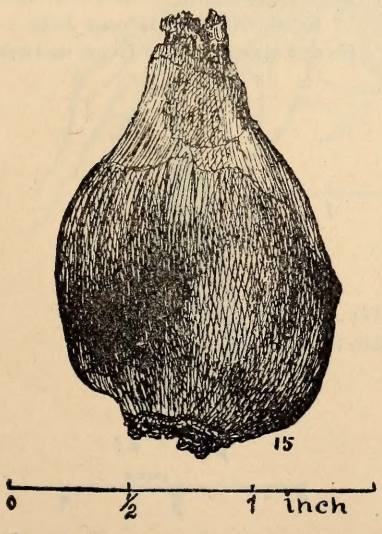
No. 13. NARCISSUS TELAMONIUS PLENUS.
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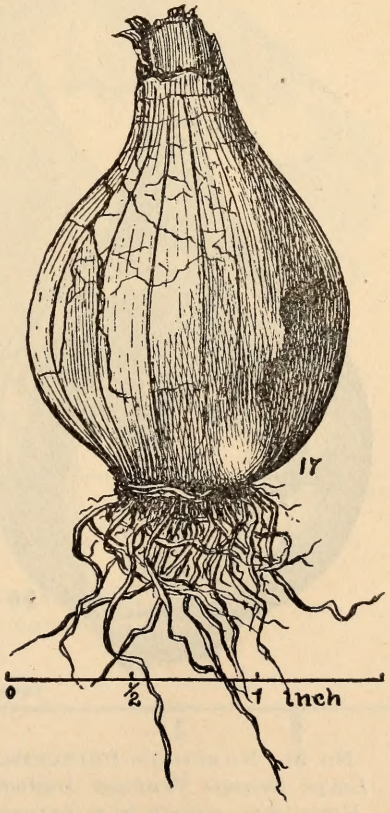
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Exact size; drawn from nature.



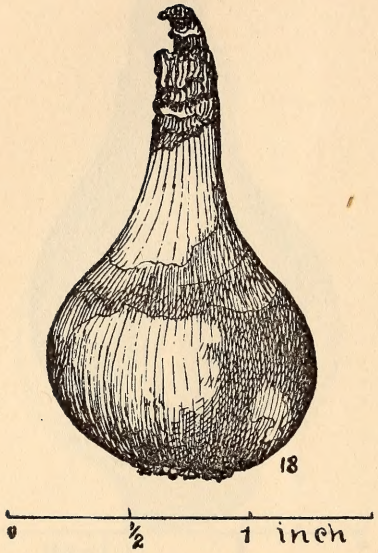
No. 16. NARCISSUS LEEDSII.
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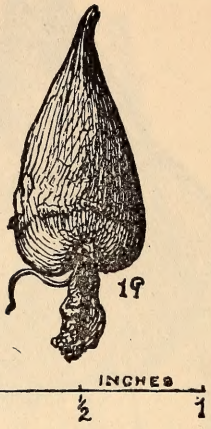
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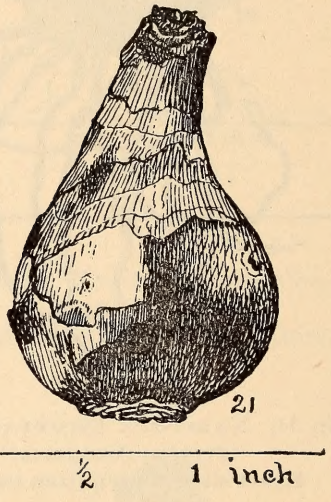
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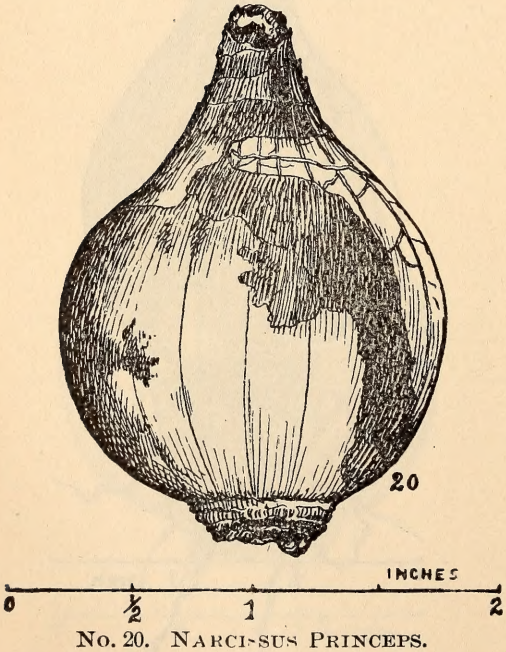
No. 18. NARCISSUS ARD RIGH.
Yellow King Daffodil (*N. Magna Coronatæ*).
Exact size; drawn from nature.



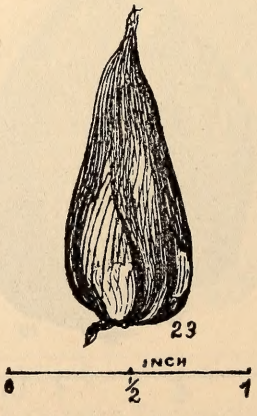
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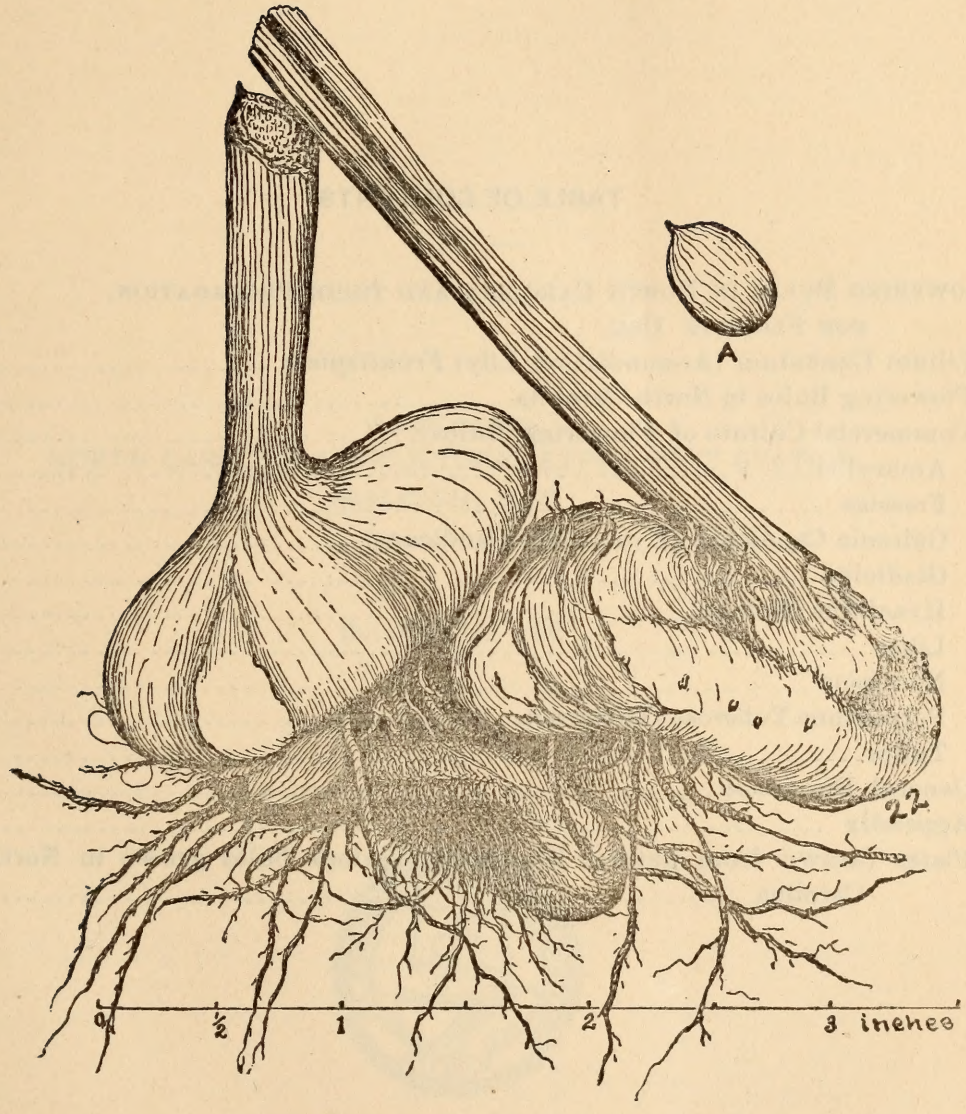
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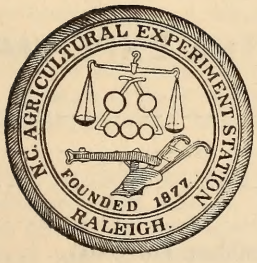
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Seed Testing

Its Uses and Methods

ISSUED BY THE
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
RALEIGH, N. C

BULLETIN NO. 108



SEPTEMBER 22, 1894
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RALEIGH, N. C.

PREFACE.

The matter contained in this Bulletin is the result of several years of labor, both in carefully-conducted tests and in data collected in this country and abroad.

The question of good seed for planting is known to be a most important one. While there are many well-established seed houses who would not knowingly deceive in placing their goods on the market, yet it is certain that there are others who are not so scrupulous, who sell bad and adulterated seed either through ignorance or design. Evidence upon this point is too strong to admit of a doubt. Even the conscientious seedsmen may be liable to buy adulterated seed, and sell them to others without knowing their true character.

Seed testing is of value both to seedsmen and to purchasers. To seedsmen on the one hand, in enabling them to understand the real nature of the material they buy before selling to others; to buyers, on the other, to enable them to know if the seed they propose planting are vital seed, and free from every objectionable weed adulteration.

An official seed control may be open to many objections, and might not be advisable at this time. A voluntary seed control does not possess the objectionable features of a legal enactment, and it may prove to be a satisfactory solution to the present difficulty. Such a control is managed without the enaction of law. It is inaugurated by means of the voluntary co-operation of both sellers and buyers, and is governed by the laws of trade and mutual benefit. The fundamental principle upon which such a control is based is the progressive spirit of seedsmen who agree to sell living seed of certain stated percentages of vitality, and free from adulterations. If after testing, it is found that the seed does not reach this quality or contains any adulterations, the seedsmen agree to take back the seed, paying transportation charges each way, or else refund a proportional part of the cost of the seed. No claim for damages to extend beyond thirty days, or after the seed is sown. The guarantee is only a guarantee that the seed is what is claimed for it, and does not extend to the quality of the crop. Evidently there are too many conditions affecting the growth of the seed in the soil for any guarantee to be given as to the yield. Bad preparation of the land, too deep or too thin covering of the seed, bad weather conditions, are some of the most common conditions injuriously affecting growth of crops, and for these the seedsman is certainly not responsible.

Competition is the soul of trade, but fair competition is possible only when competing goods are sold upon their real merits, as must be the case when seed are sold under a definite guarantee based upon a standard method of scientific analysis. If some enterprising dealers, knowing thoroughly the quality of seed they sell, voluntarily state that the goods are what they claim and subject to the above guarantee, then it will not be strange if they should commence to handle the bulk of the trade. Purchasers undoubtedly will buy where they can get the best seed for the money.

The present bulletin endeavors to show to the purchaser the prime necessity for buying only pure and unadulterated seed, and at the same time describes the value and need of seed testing. The methods and apparatus used in testing seeds are elaborated, and a seed standard and a method of voluntary seed control is suggested.

The whole matter may now be left with an enlightened and discriminating public.

H. B. BATTLE,
Director.

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SEED TESTING; ITS USES AND METHODS.

By Gerald McCarthy, Botanist.

I.

1.—THE USES OF SEED TESTING.

The seed sown upon well-prepared land is the beginning and fountain head of the crop which is to follow. Unless the seed is true to name, free from noxious impurities, and of at least average viability, the crop must fail to remunerate the sower. Although the seed is an all-important factor in the production of a crop, it is not the most expensive one. The cost of the seeding for most staple crops is inconsiderable compared with the cost of fertilizer, labor, and the yearly value of the land. Yet the failure of the seed means a more or less complete loss of the other items of expense. It is obvious then that "*for the seeding, the best is not good enough.*"

The use and value of scientific seed testing is to secure to the sower in sufficient time, a rational knowledge of the quality of the seeds he proposes to sow, and thereby protect himself against the loss and vexation of seeing his time, labor and money worse than wasted. The modern spirit of specialization and division of labor has placed the growth and purveyance of agricultural and horticultural seeds largely in the hands of specialists—seedsmen. That American seedsmen are as a whole as honest as those of any other country is without doubt true. It is equally true and proven by facts, some of which are quoted in this Bulletin, that there are in the trade persons who are neither honest nor competent to hold such responsible relationship to the agricultural prosperity of the country. The whole trade as at present conducted rests upon an unbusinesslike basis. The seedsmen are unwilling or unable to give a reasonable guarantee of the quality of their goods, and the purchaser is expected to pay current and full-weight coin of the country for goods of whose quality he has no assurance other than the word of a distant and unknown corporation or person whom he is never likely to meet. The establishment of a trustworthy standard of quality by which dealers and consumers may alike buy and sell seeds, and of a standard process of testing seeds to define their quality, is absolutely essential for further advance in the art of plant culture. Such standard and process will soon separate reputable and careful seed purveyors from those who have no reputation to lose, and seeds may then be bought and sold upon their intrinsic merits. Consumers will know what they purchase

and will be able to mix different species on a rational and quantitative basis. No honest man or corporation can be injured or embarrassed by such a course, and dishonest ones can be unmasked and exposed only by such exact and demonstrable methods as a seed testing station could employ. That the American seed market requires some such supervision in the interest of the consumer the subjoined communications and facts will serve to demonstrate.

One of the largest and most reputable seed firms in the United States has written to this Station as follows:

"You deserve very great credit for your efforts to bring about a reform in the supplying of grass seeds. The samples that are sometimes submitted to us by growers ars simply shocking. We would like to see some one placed in power in each State to pass upon the quality of samples sold to farmers. We feel sure that it would relieve *bona fide* seedsmen of a great responsibility, and would be the means of abolishing the enormous quantities of worthless seeds that are annually placed upon the market."

The following clipping from an agricultural paper, from the pen of a prominent horticulturist, may show the way some seed firms treat their patrons, and whether they need watching:

"From what I have learned through employees of some of our largest seedsmen, they are certainly not as upright as business men should be. A friend who went as stenographer to a large New England seed firm, told me, without being asked, that a bin was kept for miscellaneous varieties of pea seeds, and whenever an order came in for a variety not kept in stock, it was invariably filled from this bin. Another friend employed in one of the largest seed houses of the country, told me that it was the regular custom to run all onion seed left over from the previous year, through the fanning-mill with the fresh stock, and to send it out as "cleaned" seed. Still another friend employed in a very extensive seed house, stated, with regret, that his employers had no other interest in the handling of seeds than to get the most money possible from them without regard to moral or scientific questions."

The following extract is quoted by Dr. H. B. Battle, Director of the North Carolina Experiment Station, in the introduction to Bulletin 67 of this Station:

"A single extract from a paper read by Mr. J. E. Northup, of Minneapolis, before the Minnesota State Horticultural Society, will show what deception some seed houses adopt, and the consequent care which ought to be taken to prevent such practice from becoming widespread:

"'In walking through a large seed warehouse some time since, I detected the odor of burning brimstone, and my curiosity was aroused as to what part brimstone could play in the fitting of seed for market. Making some pretext for visiting that portion of the building from whence the fumes proceeded, I came to some cucumber seed, which was being bleached to remove the yellow tint with which age had mellowed it. The tags on the bags indicated that it had been in that building over twenty years, and how much longer no one knows.'

"In the preparation of seed, then, for the market, adulteration and deception must be guarded against, as much so as in other mercantile professions."

The following tables from Bulletin 15 of the Illinois Experiment Station show that poor seed is found in other than Southern markets:

TABLE SHOWING PERCENTAGES GROWING OF SEEDS OF KENTUCKY BLUE GRASS, RED TOP, AND TIMOTHY, TESTED IN GENEVA APPARATUS.

Number of Sample.	Kentucky Blue Grass.	Red Top.	Timothy.
1	7	16	94
2	3	*25	94
3	*1	*33	93
4	3	5	94
5	3	40	91
6	2	18	88
7	4	63	
8	2	50	96
9	6	32	58
10	0	4	59
11	0	5	75
12	2	32	42
13	0	8	57
14	0	21	81
15	0	18	78
16	1	33	69
17	1	11	52
Average	2	25	76+

*Two samples.

"It will be seen from this table that less than 2 per cent. of the blue grass, 25 per cent. of the red top, and a little more than 76 per cent. of the timothy sprouted. The maximum per cents. in each were 7, 63 and 96 respectively."

[NOTE.—Each of the above samples was purchased from a different and prominent seedsman.]

The same Station subsequently made the annexed tests of home-grown seed of Kentucky blue grass and comments as follows:

"The first tests made upon the vitality of Kentucky blue grass led to correspondence with all the seedsmen whose seeds were tested. It was stated by seedsmen that it is the practice to cut or strip Kentucky blue grass for seed while still quite green as more and cleaner seed could be obtained that way, but in curing it often heated and spoiled. It was decided to test this matter. The following table gives the results obtained:

TABLE SHOWING THE VITALITY OF HOME-GROWN KENTUCKY BLUE GRASS SEED CURED IN DIFFERENT WAYS.

Condition of gathering and keeping the seed.	Number of seeds sprouted in a gram.			No. of seeds in a gram as sown	Per cent of seeds sprouting.
	a.	b.	Average.		
Gathered green and dried on floor in a dry room	2,994	2,737	2,866	3,954	72.5
Gathered green and dried in cellar	2,976	2,768	2,872	4,014	71.6
Gathered green and dried in grain sack	3,040	2,970	3,005	4,127	72.8
Gathered ripe and dried on floor in a dry room	3,069	2,851	2,960	3,695	80.1

"The per cent. of seeds sprouting in the three samples gathered green was practically alike, being a little more than 72 per cent.; while that of the ripe seed, on the basis of the number of seeds found in a gram, was somewhat higher, being 80 per cent. The seed gathered green and preserved in any of the three ways, two of which would be presumably unfavorable, had more than three times the vitality of 18 samples of blue grass seed received from 17 firms, and twice as great as any one of the samples so obtained.

"Three points are still to be determined: the vitality if gathered still greener; the vitality during a series of years, and the length of time the seed will retain its vitality. But the tests are sufficient to indicate that a better grade of Kentucky blue grass seed may fairly be expected of the seedsmen of this country."

The following tables, reprinted from Bulletin 67 of this Station, may serve to show the quality of seeds that purchasers are liable to obtain in markets where no supervision of quality is practiced or thought of.

GARDEN SEEDS—BOUGHT IN RALEIGH, N. C.

Name.	No. of days before first sprout.	No. of days before last sprout.	Purity, per cent.	Vitality, per cent.	Valuation, per cent.	Vitality of good seed of species named should be
Cabbage, L. L. Drumhead	4	10	100	45.5	45.5	89
Cabbage, Brunswick Drumhead	3	7	100	9.	9.	89
Cabbage, L. L. Bergen	7	8	100	4.	4.	89
Cabbage, L. L. F. Dutch	3	9	100	51.	51.	89
Cabbage, E. Fr. Oxheart	4	9	100	12.	12.	89
Cabbage, E. J. Wakefield	3	14	100	58.	58.	89
Sprouts, Brussels	4	4	100	1.	1.	89
Parsley, Dbl. Curled	0	0	100	0.	0.	26
Cucumber, W. Spine	3	6	100	46.3	46.3	85
Beet, W. Sugar	5	19	100	72.5	72.5	*133
Asparagus, Colossal	0	0	100	0.	0.	90
Onion, Mammoth Silver King	0	0	100	0.	0.	85
Borecole	3	9	100	39.	39.	89
Watermelon, Ironclad	3	9	100	84.	84.	89
Tomato, K. of Earlies	2	6	100	89.5	89.5	94

DISCUSSION OF TABLE.—The above seeds were purchased in retail packets, and were sold at the same price as fresh seed. The discolored packets and the lustreless seeds suggested that they were stale seeds, and the test fully confirmed the suspicion. The retailer subsequently acknowledged that these were old seeds, and claims that they were sold to us by mistake. The packets in which these seeds were put up were marked "Warranted," but neither the grower nor the retailer have offered to refund the money paid by us for the seeds.

*Ordinary beet seeds, or more properly fruits, contain from one to seven germs.

GARDEN SEEDS—BOUGHT IN RALEIGH, N. C.

Name.	No. of days before first sprout.	No. of days before last sprout.	Purity, per cent.	Vitality, per cent.	Valuation, per cent.	Vitality of good seed of species named should be
Cabbage, E. J. Wakefield	3	9	100	34.5	34.5	89
Cabbage, L. L. F. Dutch	3	9	94	32.	32.	89
Cabbage, Henderson's E. Summer	3	9	100	53.	53.	89
Cabbage, E. Jersey Wakefield	3	9	66	28.5	28.5	89
Cabbage, E. Cannon Ball	9	9	100	12.	12.	89
Cabbage, Fottler's Brunswick	6	9	100	5.5	5.5	89
Cabbage, Surehead	5	9	100	33.	33.	89
Cabbage, Short-stem Drumhead	3	9	100	57.	57.	89
Cabbage, E. Deephead	4	10	100	44.	44.	89
Squash, R. China	3	9	100	39.5	39.5	89
Cucumber, Giant Pera	3	9	100	94.	94.	86
Muskmelon, Bay View	2	9	99	75.5	74.7	90

DISCUSSION OF TABLE.—The above seeds were put up in packets and were sold at the price of fresh seeds of the same kind. The packets were very much discolored, and showed the effects of much handling. The seeds lacked lustre, and some were badly weevil-eaten. It must be remembered that a laboratory test is always more favorable than a field test would be, and it is most probable that not one seed out of one hundred of the stale cabbage seeds would produce a good plant.

The following extract is from a recent bulletin furnished the State press by the North Carolina Experiment Station:

This Station last month reported the serious adulteration of bran with cockle, cheat and other weed seeds, and the inevitable result of feeding the bran, by which a clean field would rapidly become seeded with these obnoxious weeds, wherever the manure was put on the land.

A correspondent from Robeson County sends a seed package which reads as follows:

LATE CABBAGE.

Recommended by U. S. Agrieultural Department as the best cabbage for the Southern States. Grown and warranted by the Junaluska Seed Co., Junaluska, N. C. Price, ten cents.

Our correspondent writes: "Sometime in the early part of this spring an unknown man passed through this part of the State selling garden seed, and sold quantities of them throughout the county, but they have proven to be spurious and of no value to those who purchased them. Inclosed you will find one of the papers, also one of the plants. Can you tell us what it is? Thinking or believing it was all right, none of us asked the man his name, and have no redress."

The plant sent by him was apparently the European wild cabbage used often to adulterate cabbage seed. A communication was at once sent to a reputable seed house in western North Carolina, and a reply was promptly received saying: "We hope you can help us run the rascals down. We have heard nothing from them this season, but last year we had many complaints from the eastern part of the State and a friend sent us a seed bag. It was printed 'Cabbage Seed, grown by the Reems' Creek Seed Garden Co.' We investigated the matter and found the parties had lived near Asheville, N. C., but could not get their names to publish them. We think the Junaluska concern the same parties that swindled the people last year."

The rascals are smart, because they do not give their names. The post-offices Junaluska, N. C., and Reems' Creek, N. C., are purely fictitious, for there are not now and never have been post-offices by those names.

Out of numerous samples of Kentucky blue grass tested at this station, we have found the large majority to germinate less than 7 per cent., the highest being 20 and the lowest 0 per cent. These seed samples were in almost every case very foul, containing besides much timothy (a good but much cheaper seed), dirt, sticks, hairs, and various weed seeds. Johnson grass seed as sold in this market rarely germinates above 15 per cent., though good seed should germinate 75 per cent.

Red clover is usually the foulest seed sold in the market. Most of this seed is gathered by local merchants and sold without cleaning, thereby being the medium for scattering broadcast such pestilent weeds as plantain, wild carrot, daisy and others. Clover seed often contains considerable amounts of adulterations such as sand and quartz rock.

Other State Experiment Stations, notably Iowa, Delaware, and Connecticut, have found on their markets much weed-infested seed.

But aside from preventing carelessness in preparing seeds for the market and rendering deliberate frauds easy of exposure, there is a large field for usefulness of a testing station in educating the seed-using

public to appreciate exact scientific methods in mixing and sowing seeds, and the superior economy of purchasing only high-grade seeds. The seedsmen are not wholly to blame for the badness of much of the seed on the market. So long as farmers and gardeners demand cheap seeds, regardless of quality, just so long will persons be found to cater to the demand, even though they are obliged to debase the quality to make up for the low price. Very cheap seeds should be always viewed with suspicion. They are usually the most expensive things that the farmer can buy. Concerning cheap seeds, Dr. William Carruthers, Botanist to the Royal Agricultural Society of England, in a report to that body, remarks: "It is impossible to estimate the injury that an agriculturist does to himself when, to save a few shillings in the spring by purchasing inferior seed, he insures at harvest a crop not only poor in itself, but abundantly mixed with seeds of worthless and noxious weeds, whose injury to his crops does not end when they are cut down with the grain. In buying foul seed he is acquiring material which may prove a serious injury to his crops for years to come."

The farmer who buys such seed loses not only the present money he invests in the purchase of seed and fertilizers, and in the preparation of the land, but also the value of the increase he might reasonably have expected. But this is not all. The cost of eradicating the weeds whose seeds he has unwittingly purchased and sown with the so-called cheap seeds, and the injury they do to his succeeding crops, must also be considered. One sample of clover seed recently examined at this Station contained over five per cent. of dodder seeds. The dodder is a parasitic plant which feeds upon the juices of clover and related plants. It is extremely difficult to get rid of when once introduced into a field. Its seed have been known to sprout after having been buried in the earth for four or five years. Oftentimes newly seeded clover fields may be seen in which there appear to be more plantain, sheep sorrel, daisy and carrot than clover. The old problem of the different possible ways in which wheat may turn to chess is still discussed where farmers meet. These things will continue to be as long as low-grade seeds, containing weed seeds, are sold and sown.

But there is another side to the question. Unless the farmer knows the quality of the seeds he proposes to sow, his calculations are, at best, mere guesswork. He has no rational basis upon which to calculate. He cannot make a rational mixture of seeds, so as to give a definite proportion of the bearing capacity of the land to each species. He cannot tell which species of a mixture will furnish the bulk of the herbage. Yet he cannot afford to sow upon land brought at great expense to its maximum point of productiveness, seeds of whose quality he knows nothing, and for whose quality the seller distinctly repudiates all responsibility.

The following guarantee is printed in the catalogue of one large English seed firm, and is substantially the same as that given by all

English guarantee houses, who have a "private contract" with some seed-testing station:

1. "Our seeds are sold, guaranteed pure, clean and of the percentage of vitality named in our catalogue.
2. "This guarantee is subject to the analysis of the Botanist of the Royal Agricultural Society.
3. "If the result of the analysis does not confirm the above guarantee, we will take back the seeds and pay cost of carriage both ways, but seeds must not be sown before making complaint.
4. "The seeds once sown, our responsibility ceases. The result depends upon so many things besides the quality of the seeds that the growth cannot be guaranteed."

Contrast the above rational and civil treatment of customers with the following disclaimer, which is printed, with some variations, in the catalogues of most non-guarantee houses:

"We wish to be distinctly understood that, although we continue to take all possible pains to supply only new, genuine and unadulterated seeds, yet we still give no warranty, express or implied, as to description, quality, productiveness, or any other matter, of any of the seeds we send out, and will not be in any way responsible for the crop. Every order received for articles named in this catalogue will be executed on these conditions only."

2.—SEED TESTING IN THE UNITED STATES.

Until about nineteen years ago no serious attempts were made in the United States to investigate the quality of feed stuffs, fertilizers or seeds sold to farmers, although European countries, notably the German States, have had experiment and control stations doing practical and useful work in this line for forty years. In the United States prior to the financial panic of 1873 the conditions were not favorable for inaugurating scientific, exact and economical farming. With a favorable climate, an almost virgin soil, easy transportation, high prices, slight competition and the world's markets in which to sell, the American farmer seemed to be the spoiled child of nature. He felt above the necessity for economy, or was engaged in pioneer work to which the maxims of economy do not always apply. About the date named, or a little before, the inevitable result of our former methods of farming began to be felt, and the feeling has grown more acute each succeeding year. That there were and are still other factors at work sapping the American farmer's prosperous estate is undeniable, but these need not concern us here. The farmer's troubles have sufficiently taught him the value of exact and economical methods. He is now anxious to learn how to restore the fertility of his depleted soil by means of rationally-compounded fertilizers, improved methods of tillage and rotation of crops, cleaner and better seeds, etc. The rapid increase of the commercial fertilizer trade with its occasional exposures of fraud soon showed the desirability of bringing in chemical skill to control this trade and prevent imposition on farmers.

Later there developed a similar desire for the investigation of the seed trade and of the quality of seed being offered for sale. Since

the establishment of the experiment station system in the United States more or less work in this line has been done by different stations. The first station conducting seed tests in America was the Connecticut Station in 1877, two years after its establishment. Soon thereafter, February 21, 1879, seed investigations were commenced at the North Carolina Experiment Station, the work having been done under the direction of Dr. Albert R. Ledoux, who imported the methods and apparatus used in some of the German Stations. The work begun here in 1879 has been continued in connection with various other lines of botanical investigation at the Station and a vast amount of data has been accumulated, some of which has already been published. For details of this work, see Bulletins 59, 63, 67, 73.

Very early in the investigation into the quality of the seeds in the market, the need of an exact and determinate standard of quality was felt. An attempt to elaborate such a standard soon showed the futility of ordinary field or soil tests over which the investigator has little or no control. A determinate standard must be based upon exact, accurate and controllable methods such as can be carried on only when all the factors concerned in setting into activity the vital energy of the seed—heat, moisture, light, oxygen, etc.—are fully under control. The only practicable and useful standard possible is a Laboratory Standard.

This point in our investigation was reached in 1889, and it was thought best to attempt to enlist the more enterprising seedsmen in the subject. To this end, in the spring of that year a circular* was sent out to all the larger seed firms in the United States and to many in Europe. Following the preliminary notice subjoined the circular contained three pages of plant names, including all the more important field, garden and flower plants. Concerning these seeds was asked the following questions:

1. What percentage by weight of impurities should be allowed in a choice sample of this seed?
2. What percentage of viability should be required?
3. What is the maximum age to be allowed for commercial samples of such seed?
4. What is the maximum, minimum and optimum temperature for germinating this seed?

To this circular the Station received about 120 answers. Some of the oldest and best-known seedsmen in the United States, England, Germany and Switzerland furnished very complete and detailed answers which have since proved of the utmost value in the seed work carried on at this Station. All of the replies except those of the Control Stations in Germany and Switzerland showed, however, the impossibility of securing exact and comparable data from diverse and empirical methods. By combining such reports as were not conflicting and elucidating others by special investigations carried

*See Appendix for circular.

out for that especial purpose, we have been able to collate the majority of these reports, and with such additions as we have ourselves abstracted from the records of this Station, the data is now presented to the public in the following pages.

There has been considerable discussion as to whether the European system of seed control is practicable or desirable for this country. It would seem plain to average people that any system which discourages carelessness and roguery, which stimulates enterprise and zeal, and protects honest traders against the unscrupulous ones is worthy of adoption until a better can be found.

3.—THE SEED CONTROL SYSTEM IN EUROPE.

The idea of controlling the quality of seeds offered for sale in the market by scientific methods is not new. The first institution for testing the quality of commercial seeds, according to modern scientific methods, was established at Tharandt, in Germany, in 1870. Since then similar institutions have been established in nearly all the States of the German Empire, and in Austria, France, Switzerland, Italy and Denmark. In England, the Royal Agricultural Society employs a skilled botanist to test seeds for members. All of these institutions are controlled by State governments, and are supported partly by grants of public funds and partly by fees. The organization of the different stations consists of a reputable botanist at the head, with a corps of trained assistants.

Seed samples are tested only as to their purity and power of germination, in so far as these facts can be ascertained by botanical inspection, the separation and weighing of foreign matters, and by germinating tests of the seeds in specially constructed apparatus. It is possible for a competent botanist to discriminate between the seeds of most species of plants by microscopic examination, but it is not always possible by this means to distinguish the seeds of mere varieties. Thus a botanist can by simple inspection and without trouble distinguish turnip seed from cabbage or radish seed, but cannot discriminate one variety of cabbage seed from another. This can be done only by actually growing the plants. For testing varieties most European seed control stations have trial gardens, but the genuineness of the variety is not guaranteed or tested except under a special agreement and by payment of a special fee. The germinative power of the seeds is ascertained by actually testing a sample. Usually 400 genuine seeds are taken without deliberate selection from the sample to be tested. These are divided into two equal portions and tested in separate dishes of the apparatus. The average of the two lots is taken for the mean viability of the original sample. Where the difference between the two lots exceeds 10 per cent. the test is discarded and repeated. The purity of the sample is determined by first weighing it and then separating and weighing the foreign matters and calculating their percentage of the whole weight.

The impurities are further separated and weighed according to their specific nature and are usually arranged under three categories—useful seeds, noxious seeds, and inert matter. The real or cultural worth of the sample is found in terms of per cent. by multiplying the purity percentage by the viability percentage and dividing the result by 100. Thus $\frac{\text{Purity} \times \text{Viability}}{100}$ = Real worth. The apparatus used in the different testing stations, though differing more or less in details, is based upon the same principles. The seeds are supplied with the amount of warmth and moisture which experience has shown to be most conducive to the growth of the different species. The tests are therefore always more favorable to the seeds than an outdoor soil test would be. In a country where there are more than one testing station, it is very desirable that the stations shall all use the same apparatus and method, in order that the work of different stations may be directly comparable and serve as mutual checks. The most celebrated seed control station in Europe is located at Zurich, under the patronage and control of the Swiss government. This station has an international reputation and does testing for seedsmen in all parts of Europe. It does not affiliate with the German stations, and its methods differ somewhat from those used in Germany. The methods of the Swiss station are those most applicable to the American social and political system, and to the needs of the American seed trade. By act of the Swiss Federal Congress, all seed dealers, without exception, offering seeds for sale within the confines of the republic, are obliged to have their seeds tested at the Zurich station, and to brand or otherwise mark each retail package with the percentage of pure vital seed as reported by the station.

For foreign patrons the station has two systems—first, the "private contract" by which, for a specified sum per annum, each patron has the right to have a certain number of samples tested for his own satisfaction. Under the private contract system, the Swiss station has no connection with the customers of its patrons. The second system is the "control contract." Under this contract each patron has, as under the private contract, the right to have a certain number of samples analyzed and reported upon; and in addition to this, it has the right to print on its advertisements the legend: "Under control of the Swiss Seed-Control Station." All seeds are sold under a specific guarantee of purity and vitality, and each customer of the control contract patron has the privilege of sending to the station, free of charge, a sample of the seeds bought by him, and if the same falls short of the guaranteed quality, the seller is compelled to give a commensurate reduction in price, or to receive back the seeds, paying carriage both ways, as the purchaser prefers. To protect the dealer from imposition, the customer who proposes to send a sample to the station is required to take the same, in the presence of two responsible and disinterested witnesses, from an unbroken package sent by the seller, and this sample must be bagged, sealed and mailed

in the presence of the same persons, who sign a certificate to that effect, which is mailed to the station with the letter of instruction.

The "control contract" system is preferred by Swiss seedsmen and by most houses within a reasonable distance of Zurich; the "private contract" system by those more remote. In a list of its patrons published in 1888, the Swiss Station gives the names of twenty-four foreign houses as having private contracts, of which ten are in Germany and eight in Great Britain. During the year 1893 more than 150 seed firms had private contracts with the Zurich Station.

With a view to ascertaining the result of the control system in Europe, the North Carolina Experiment Station some time ago sent to each of these contract houses a circular of inquiry. Replies were received from all, and, without exception, were favorable to the system. The following are extracts from a few of these replies—those originally in German or French being here translated:

Carl Seibenmann, Basle, Switzerland.—"Ours is a wholesale house under a 'control contract' with the Zurich Station. We sell cheap non-guaranteed seeds to those who want them, but the majority of our customers, which are associations of farmers, demand controlled seeds. It is indisputable that the control system is of great importance and has done immense good, especially in the trade in agricultural seeds. It is known to us that formerly many merchants sold seeds with very little vitality, and clover seed which was adulterated with spurious kinds and with stained quartz grains. By such means these merchants were able to undersell honest houses, to the detriment of agriculture."

Kent & Bryden, Darlington, England.—"We have a 'private contract' with the Zurich Station. The advantage is that in purchasing seeds in bulk which may be of doubtful quality, we are able to send a sample to Zurich and quickly get a reply, stating the purity of the sample and whether it appears to be of good quality, and later we get the full report of the test. The seeds sold in this market have greatly improved in quality since purchasers have demanded guaranteed seeds. We believe it to be of very great importance to have a standard of quality. If such were established, seeds could be bought and sold by it. We offer all our seeds subject to the standard adopted by the Royal Agricultural Society of England."

David Allister, London, England.—"I have a private contract with the Station at Zurich. The advantages of such an establishment to agriculture and to seedsmen is very great. Many kinds of seeds have improved since the establishment of the testing stations. Especially is this noticed in grass seeds, such as meadow fox-tail, meadow fescue, cock's-foot, sweet vernal, rough-stalked meadow grass, etc., which formerly were either greatly adulterated or had other seeds wholly substituted for them. Seedsmen now vie with each other in procuring the finest and truest qualities of seeds, and the percentage of purity and vitality being ascertained through the testing stations, they *guarantee* them to their customers."

Wallich-Swansfeld, Inspruck, Tyrol.—"I have a private contract with the Zurich Station since 1887. I sought this to increase the confidence of the public in my seeds and to protect myself in purchasing. I think the Swiss Station is not excelled in its line of work. The quality of seeds in the market, especially clover seed, has improved every year since the establishment of control stations in the different countries of Europe. I would not require merchants to sell seeds of any fixed quality, but only to guarantee a definite quality under regulations similar to those established by the Swiss Station at Zurich."

Laroye & Vankerschoffer, Ostend, Belgium.—"We have a private contract with the station at Zurich. The advantages of such a station are multiple. By this means we are able to learn the quality of seeds we propose to buy, and thus protect ourselves and our customers. Purchasers now have greater confidence in the seeds they buy of us. The 'control contract' system of the Zurich Station has even greater advantages, but the conditions are onerous. The quality of seeds in the market has, in effect, improved since the advent of the testing stations, the

samples being now much cleaner. We have also better machinery than formerly for cleaning seeds, but this is also, in part, due to the educational work of the seed testing stations."

J. Lambert & Son, Frier, Switzerland.—"We have a private contract with the Zurich Station. We think it is a very good thing, because it gives us an advantage in selling seeds to consumers and to other merchants. The seed trade has been carried on in a very bad and unfortunate manner, and until recently there was no real security for the purchaser, whether the seeds were good or bad."

Agricultural and Horticultural Association, London, England.—"We have a private contract with the Zurich Station. We get reliable tests at reasonable rates, and have found every detail complete and satisfactory. There has been very great improvement indeed since the guarantee system of selling seeds came into use."

The following from the manager of the Association is of interest:

"DEAR SIR: We are glad to hear that an interest has been aroused in North Carolina upon the question of the quality of seeds. The custom of guaranteeing seeds is sufficiently well established to show that it is possible for all respectable seed firms to carry out the plan if they are willing to do so. It is true that a very great many seedsmen hold back from giving guarantees, but we are quite sure they will be compelled to adopt this method or gradually see the more intelligent agriculturists taking their custom where they can be guaranteed reliability of supply. It is quite true that 150 houses are affiliated to the Swiss International Testing Station at Zurich, and we should say the majority of these give guarantees to their customers, although very likely they do not all do so. On the other hand, a good many houses sell on guarantee who are not affiliated to the Zurich Station. In this case they guarantee according to the tests of Professor Carruthers, of the Royal Agricultural Society, Professor McAlpine, of the Highland and Agricultural Society, or other acknowledged authority.

"If your farmers and landowners are wise they will support the movement you have commenced; and if the seedsmen prove obstinate, then the agriculturists could not do better than copy the example of the British agriculturists, who have established this Agricultural and Horticultural Association for co-operative supply. For your information, I may mention that our Association now numbers nearly 3,000 members, has a business approaching £80,000, or $390,000, and is progressing in a most satisfactory way. It is worked upon the plan of sharing profits with the employees and the customers, the latter being the proprietors. Yours faithfully, EDWD. OWEN GREENING."

James Hunter, Chester, England.—"I introduced the guarantee system into England in 1882, and since then several of our largest seed firms have adopted the system, and very marked improvement in the quality of seeds has taken place."

Dickson's Seed House, Chester, England.—"We clean our seeds to the greatest attainable perfection, and guarantee them to our customers to be of the percentage of purity and vitality stated in our catalogue, and sell them subject to the analysis of the consulting botanist of the Royal Agricultural Society."

James Carter & Co., London, England.—"We guarantee our seeds, according to the quality purchased, to be of the highest average vitality of the season, and it is open to any purchaser to submit them to professional analysis."

Dr. William Carruthers, Botanist Royal Agricultural Society, London, England.—"During the past year, 1890, I have examined for members of the Royal Agricultural Society 341 samples of seeds. The general result noticed is a continual improvement in quality, but it is apparent that a great deal of utterly bad seed still finds its way into the hands of farmers. The purchaser of seeds should obtain from the vendor, by invoice or otherwise, a guarantee that the sample contains not more than a specified amount of other seeds, and that it is free from ergot and dodder, and a statement of the percentage of seeds that will germinate. The council of the Royal Agricultural Society strongly condemns the purchase of ready-mixed seeds for grass land."

J. L. Beney, Valleyres, Switzerland, President Agricultural Society.—"We are very much satisfied with the control of seeds exercised by the Experiment Station at Zurich. It renders great services to our agriculture."

Raynbird & Co., Basingstoke, England.—"Ours is a private contract with the Zurich Station. We sell our seeds with a specified and guaranteed percentage of purity and germinating power. We send herewith our last price-list of field seeds, which will show what we mean. We have the most improved machinery for cleaning seeds at our mills, and send out only the best obtainable samples."

Damann & Co., San Giovanni, Italy.—"We do not hesitate to declare that a seed control station like that of Zurich would be a great advantage both for the seller and the buyer of seeds, since it would be equally valuable to both to know exactly what they are offering and buying."

Fratelli Ingegnoli, Milan, Italy.—"We have a private contract with the Seed Control Station in Zurich, Switzerland. A guarantee of the purity and vitality of seeds we regard as of vital importance. For certain grasses the purity may be approximately judged by visual inspection, but the germinative power can be determined satisfactorily only at a botanical station. We have a government station for control of seeds at Modena, Italy, but we prefer to have our seeds tested at Zurich, because that station has a world-wide reputation for the thoroughness of its work."

H. Keller & Son, Darmstadt, Germany.—"We have had a private contract with the Station at Zurich for about five years. The advantages offered by a station as well conducted as the one in Zurich are very great. The Zurich Station is the most trustworthy and careful of all the stations in Europe, and has had the most experience. The different European stations proceed by different methods, and the result is that each station, from one and the same lot of seeds, obtains different results. Germany has a large number of seed control stations, among which the better known are those in Tharand, Kiel, Breslau, Bonn, Münster, Karlsruhe, Darmstadt, and Hohenheim. There is also a control station in Vienna, Austria. There can be no reasonable doubt but that the seeds in commerce have greatly improved since the establishment of test stations, about ten years ago. We think the guarantee system of the greatest value to the seed trade, but it is our judgment that the test stations should be private establishments and that governments should not establish a minimum grade or standard for seeds."

Jacob Morel, Sins, Switzerland.—"Ours is a control firm under the regulations of the Zurich Station. We quote you the following guarantees as published by us in our last catalogue:

	Purity.	Vitality.
Trifolium arvense	98 per cent.	93 per cent.
" pratense	96 "	95 "
" hybridum	94 "	70 "
" repens	96 "	93 "
Medicago Sativa (Provence)	97 "	90 "
" lupulina	99 "	62 "
Festuca pratense (German)	95 "	92 "
Alopecurus pratensis	85 "	70 "
Agrostis stolonifera (American)	96 "	88 "
Phleum pratense	99 "	97 "
Dactylis glomerata	56 "	78 "
Arrhenatherum avenaceum	74 " / 90 "	72 " / 75 "
Lolium Italicum	97 "	80 "
Lolium perenne	98 "	93 "
Avena flavescens	96 "	42 "

4.—THE METHOD OF SEED CONTROL.

The long experience and international patronage of the Swiss Seed Control Station at Zurich seems to show that the "private contract" or voluntary guarantee system is practically as efficient as the legally enforced State control system established in Switzerland. When seed merchants find a public demand for a definite guarantee of the purity and viability of seeds, the more enterprising seedsmen will be only too glad to meet the demand, and the others, doubtless, will soon follow. All that is necessary is a definite published method of analysis by which seedsmen may buy as well as sell. This attained, the goods of competing seedsmen will be sold upon their merits, and honest and careful merchants will not have to compete with those who are neither honest nor careful.

The following outline of a scheme for voluntary co-operation between the experiment stations, representing the general public, and the seed trade for mutual benefit, is offered tentatively and subject to emendation:

1. The Association of American Experiment Station Workers to adopt a standard form of apparatus and process for examining and testing seeds, and the use of these to be obligatory on all stations publishing work in seed testing. No changes to be made in apparatus or method until the same has been authorized by the Association or a committee of the same.

2. Seedsmen entering into the agreement to be furnished, at their own cost, with the official apparatus and methods, and they to test their own seeds or have them tested according to the official process by private or public testing stations, and to guarantee a definite and stated percentage of viability, purity and "real worth" according to the official method.

3. Leguminous seeds are, in addition, to be guaranteed to be free from dodder, cereals to be free from cockle, and rye seed to be free from ergot.

4. A purchaser of seeds to be allowed to take from any package in the presence of a disinterested and reputable witness a sample, and seal and mail the same to the Experiment Station of the State in which purchaser lives. The sample for testing must be taken according to the official method and a certificate to that effect must be signed by the aforesaid witness and mailed to the station with the sample. If the station's test shows the sample to fall more than 5 per cent. below the guaranteed "real worth," the seedsman making the guarantee to make a commensurate reduction in price or receive back the seeds, paying carriage both ways, as purchaser may elect. The seedsman is always entitled to a margin of five per cent. to allow for the possible error of analysis.

5. Where seedsmen guarantee the varietal genuineness of their seeds, samples for testing must be large enough to furnish 100 viable seeds in addition to those required for the germinating test. Where seeds prove untrue to name, the seedsman to reimburse the purchaser to the full amount guaranteed.

6. The guarantee given by the seedsman to cease with the sowing of the seed, or after thirty days from the day the seeds were received by purchaser.

The above outline is substantially that which has for some years been in operation by several large English seed firms who are affiliated with the Zurich Seed Testing Station, and who guarantee the quality subject to the analysis of the Botanist of the Royal Agricultural Society of England. This scheme, while affording ample protection to the public, seems to be entirely fair to the seedsmen, and should therefore be welcomed by the honest and more progressive members of the trade.

It has been objected that the seedsmen have no voice in determining the honesty and competency of the men who do the testing in the stations. It is of course possible that a station may have incompetent workers and publish untrustworthy work, but where all the stations use the same method, the work of each acts as a check upon the others, and stations doing untrustworthy work will quickly be recognized and their work stigmatized with merited discredit.

It may be assumed that honest and careful seedsmen will be glad to receive the protection that this plan offers in exposing and publishing the operations of irresponsible dealers, and that they will voluntarily co-operate with the stations. By making such tests, and annually or more frequently publishing the results, the public will soon come to see which seedsmen offer the best goods for the money, and these will soon monopolize the bulk of the trade.

[The complete bulletin contains seventy-six pages, and the subject-matter can be seen by reference to the table of contents on page 348. Persons who do not receive pages 361-416 can be supplied by making application to DR. H. B. BATTLE, Director, Raleigh, N. C.]

II. THE PHYSIOLOGY OF THE SEED.

1.—THE STRUCTURE OF THE SEED.

All of the higher class of plants—the *phanerogama* or *spermaphyta*—the plants which form the staples of agriculture—propagate their species by seeds. The seed is a special structure, always developed in a closed pouch or ovary, which is usually termed the fruit. The seeds of phanerogams are produced by the union of two sexually distinct organs, or as some call them *plants*. The first is the female organ, or plant, which is produced from a self-fertilized egg and eventually developes into the endosperm or food reserve of the seed; the second or male part is produced from a cross-fertilized egg and

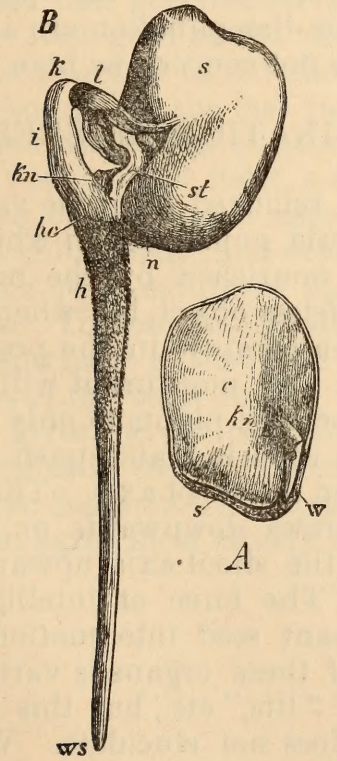


Fig. 1. EMBRYO OF HORSE BEAN.

A. Embryo with one cotyledon removed to show root and shoot buds; *c.* remaining cotyledon; *w.* root bud; *k.n.* shoot bud; *s.* testa or epidermis.

B. Germinating seed; *s.* testa; *n.* hilum; *st.* petiole of one cotyledon; *k.* flexure of epicotyledon; *hc.* hypocotyledon stem; *h.* the main root; *ws.* tip of main root; *kn.* axillary bud of cotyledon.—*After Sachs.*

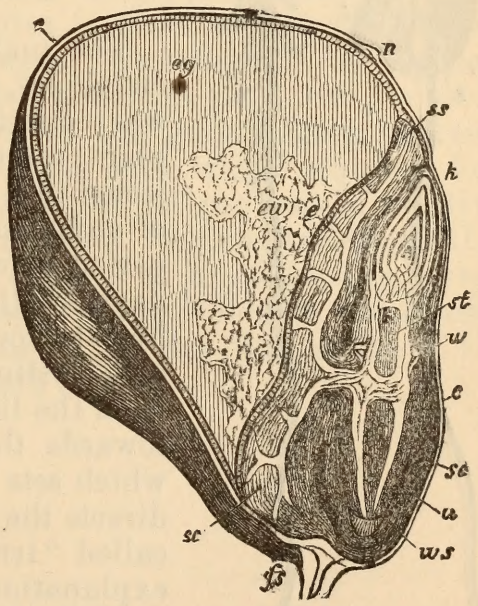


Fig. 2. LONGITUDINAL SECTION OF THE SEED OF INDIAN CORN, magnified six diameters.

c. epidermis or testa; *n.* place where the "silk" was attached; *fs.* base of seed; *eg.* yellow and dense portion of endosperm; *ew.* white and spongy portion of endosperm; *sc.* scutellum or "mouth" of embryo through which it absorbs the endosperm; *ss.* tip of scutellum; *e.* epithelium or skin of embryo; *k.* shoot bud; *w.* (below) root; *w.* (above) prop roots; *ws.* root sheath; *st.* first internode of shoot.—*After Sachs.*

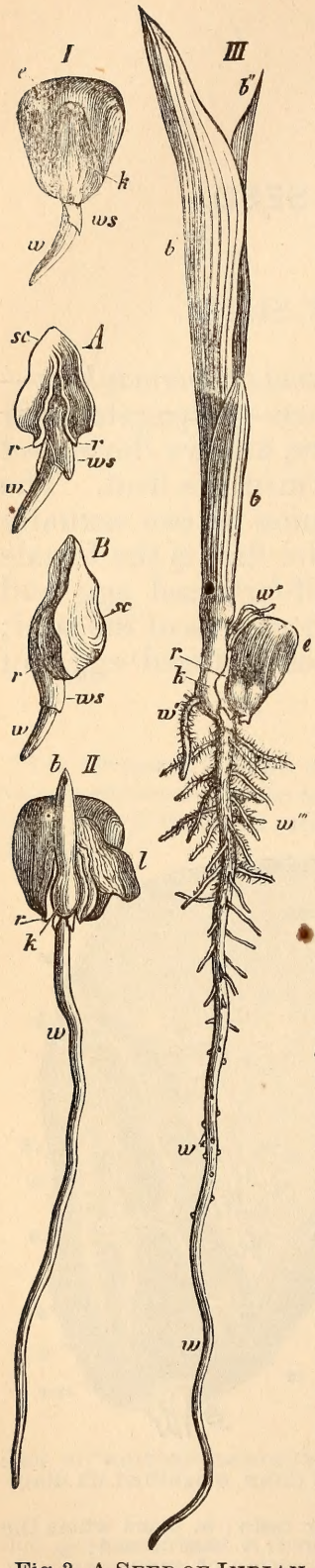


Fig. 3. A SEED OF INDIAN CORN, in three different stages of sprouting.

A. Front view. B. Side view; *w.* main root; *ws.* root sheath; *w. w'. w''.* prop roots; *e.* part of seed containing endosperm; *k.* shoot bud; *sc.* scutellum of embryo; *r. r.* the open "mouth" or scutellum; *b. b''. b'''.* first leaves of plant.—*After Sachs.*

developes into the germ, kernel or embryo of the seed. During the process of ripening of the seed or during its germination the kernel or embryo consumes the endosperm.

A good example of a seed in which the endosperm is consumed by the germ during the ripening process is the common garden bean. An example of a seed in which the endosperm is consumed during germination is the Indian corn or maize. See Figures 1, 2 and 3.

Spermaphytes are still further divided into two classes, distinguished by the number of cotyledons, or seed leaves, which the embryo possesses. Most of our hardy shrubs and herbs belong to the dicotyledonous class. The cereal grains, grasses, and garden flowers of the lily tribe belong to the monocotyledonous class. The conifers have more than two cotyledons—usually five or seven.

The exterior form of seeds and the appendages for procuring their dissemination are almost endless, but these do not concern us here.

2.—THE GERMINATION OF SEEDS.

The mature seed, removed from the various envelopes, pod, capsule, pome, etc., in which it was concealed and nourished by the mother plant, resembles a lifeless object, but when subjected to a certain temperature in the presence of sufficient oxygen and moisture it will, in a period amounting for most plants to only a few days, swell, burst its covering and push forth first the root and then the shoot axis. The root axis instinctively grows downwards or away from the light, and the shoot axis upwards or towards the light. The force or intelligence which sets the dormant seed into motion and directs the growth of these organs is variously called "irritability," "life," etc., but this is an explanation which does not elucidate. Whatever the nature of the controlling power may be, it is liable to be lost without any apparent change in the outward form or organs of the seed. We know, however, that the moisture absorbed by a mature and viable seed, when the

temperature is favorable, first dissolves part of the starchy food reserve which is changed by a ferment, diastase, also contained in the seed, to sugar, and this is absorbed by the root and shoot buds of the embryo causing them to elongate and grow—in other words, the seed germinates.

The presence of sufficient moisture to cause the seeds to swell is the first and most fundamental requirement. Many experiments have been made to discover whether pure water or aqueous solutions or mixtures of various chemicals are best to hasten the germinating process. Nobbe, in his *Handbuch der Samenkunde*, p. 102, *et seq.*, details many experiments in this line, the results of which showed that pure distilled water causes the most rapid swelling, and consequently the quickest germination of the seed.

The nature of the outer seed coat or *testa* of seeds differs more or less in different plant families. In the *Leguminosæ*, or pulse family, the seed coat is often so hard that mature and viable seeds often remain unsprouted in the ground for years. Out of a sample of 1,000 seeds of kidney vetch placed by Professor Nobbe in a moist chamber, kept at a constant temperature of from 65°F. to 70°F., while 840 seed had germinated after the expiration of 36 hours, the last viable seed germinated only after 260 days. Under like circumstances a sample of red clover gave 90 per cent. of germinated seeds in 24 hours, but the last viable seed germinated only after 156 days. It is an interesting question how much water, compared with the weight of the seed itself, a seed requires to start the growth of the embryo or begin the sprouting process. Experiments by Nobbe, Sachs, Hoffmeister, and other European botanists, show that the seed must be quite saturated by water before the germinating process begins. To completely saturate the seed with water requires for some species, *e. g.*, the horse bean (*Vicea Faba*), 157 per cent. of the dry weight of the bean itself. Hoffman (*Landw. Versuch-Stationen*, VII., p. 47) gives the per cent. in the first column of the following table, the figures in second column are those given by Nobbe in the *Handbuch der Samenkunde.* Some experiments in this line at the N. C. Station agree most closely with Nobbe's figures.

Genera of Plants.	Water absorbed in swelling, in per cent. of dry weight of seeds.	
	According to Hoffman.	According to Nobbe.
Wheat	45.5	60.0
Barley	48.2	....
Rye	37.7	....
Oats	39.8	....
Buckwheat	46.9	....
Corn	44.0	39.8
Millet	25.0	....
Peas	106 8	96.0
Horse Bean	104.0	157.0
Vetch	75.4	....
Lucerne	56.0	87.8
White Clover	126.7	89.0
Red Clover	117.5	105.3
Rape	31.0	48.3
Hemp	43.9	....
Sunflower	56.5	....
White Beet	62.5	51.8
Sugar Beet	120.5	....

As a rule the smaller oleaginous seeds and cereals have the least water-absorbing capacity, while the legumines have the greatest.

3.—THE PROXIMATE COMPOSITION OF THE ENDOSPERM.

Many analyses of the endosperm, or food reserve, of seeds show it to be a very complex substance. The nitrogenous portion in most seeds is in the form of gluten-fibrin or gluten-casein, which is insoluble in water, but completely soluble in dilute solutions of acetic acid, hydrochloric acid, tartaric acid, malic acid and citric acid, and in dilute solutions of potash and soda. *Gliadin*, another component of the albuminous part of cereal seeds, is fully soluble in all the above-named media, and slightly soluble in pure water. *Mucedin*, the third component of cereal albumins, is fully soluble in water. Different families of plants possess peculiar forms of albumin; for example, the legumines have *legumin*, which differs from *gliadin* by a higher content of sulphur.

The non-albuminous part of the endosperm is composed chiefly of starch, oil, and parenchyma. Starch plays a very unimportant role in the composition of the ripe seeds of most agricultural plants. It occurs as a transitional constituent in the growing seed, but disappears in the ripening process. According to Naglei, in about nine-tenths of all the natural families of plants, the ripe seed is free from starch.

4.—THE MINERAL CONSTITUENTS OF THE SEED.

The mineral part of the ripe seed forms but a very small per cent. of its total weight.

The following table of ash analyses of seeds is from Dr. Emil Wolff, except the cotton and tobacco, which are from records of the N. C. Experiment Station:

Seed of Plants.	Ash. Per Cent.	Potash. K_2O Per Cent.	Lime. Ca O Per Cent.	Phos. Acid. P_2O_5 Per Cent.	Silica. $Si O_2$ Per Cent.	Magnesia. Mg O Per Cent.	Sulfuric Acid. $S O_3$ Per Cent.
Winter Wheat	1.97	31.16	3.34	46.48	2.11	11.97	0.37
Spring Wheat	2.14	29.99	2.93	48.63	1.64	12.09	1.52
Rye	2.09	31.47	2.63	46.93	1.88	11.54	1.10
Oats	3 14	27.96	7.46	47.73	1.16	10.12	----
Indian Corn	1.51	27.93	2.28	45.00	1.88	14.98	1.30
Buckwheat	1 37	33.07	4.42	48.67	0.23	12.42	2.11
Peas	2.73	41.79	4.99	36.43	0 86	7.96	3.49
Beans	3 57	31.90	6.38	35.52	0.57	7.62	4.05
Vetches	3.10	30.14	8.03	37.55	1.31	8.95	3.69
Lupines	3.95	29.84	8.90	41.97	0.42	11.64	4.31
Red Clover	4.50	35.35	6.40	37.93	1.30	12.90	2.40
Rape	4.44	24.50	4.18	42.33	1.42	11.80	2.39
Flax	3.69	30.63	8.10	41.50	1.24	14.29	2.34
Cotton	3.53	33.90	6.68	31.05	0.07	15.82	5.83
Tobacco	3.15	28.40	3.60	39.36	0.40	21.84	1.59

The above table is valuable as showing the mineral matters essential for maturing viable seeds, the amount of each ingredient removed from the soil, and the comparative quantities in which these are required.

5.—THE EFFECT OF TEMPERATURE ON THE GERMINATION PROCESS.

Seeds are very sensitive to the effect of temperature, both while they are growing and while dormant. As regards dormant seeds, it makes a great difference whether dryness or moisture accompanies heat. Soft seeds, whose cells are full of sap, can stand much less variation of temperature than harder and drier seeds. The limits of temperature within which the seeds of different genera of plants will retain their viability has been experimentally determined by Sachs, Hoffmeister, Nageli, Nobbe, and other European and American botanists. The general agreement is that in ordinary dry air well ripened seeds will endure, unharmed, almost any ordinary fall of temperature, at least as low as —40°F. At the other extreme the larger and drier seeds, *e. g.*, cereals, beans, peas, etc., are able to withstand a dry temperature of 212°F., or above for a short time. Seeds which

have been exposed to an extraordinary high temperature within the limits of their resisting power, according to Nobbe, germinate more quickly than similar seeds not so exposed. When dormant seeds are exposed to a moist heat, *e. g.*, at 138°F. for above ten minutes most small seeds have their viability destroyed; larger seeds, such as Indian corn, beans, etc., may withstand that temperature for fifteen minutes with the loss of from 40 to 70 per cent. of the seeds. The genus *Cytisus*, however, will withstand a temperature much higher, and in practice it is customary, before sowing such seeds, to throw the seeds into boiling water just removed from fire and allow them to remain therein until the water has become cold. All cereal seeds are rendered unviable by a moist temperature of 150°F., enduring as long as five minutes. A constant temperature of 95°F. in water, or 105°F. in moist sand will destroy the germs of all cereal, and most other seeds, in a few days. The ordinary summer temperature of the moist low lands of the South Atlantic and Gulf coasts is alone sufficient to destroy the viability of many species of seeds during one season.

There is for each genera of seeds a maximum moist temperature above which the embryo suffers, first, a hindrance of development and then disorganization. There is, likewise, a minimum temperature below which similar results occur, but the death of the embryo is more certain to follow upon excess than deficiency of heat. So long as the cell walls are not ruptured by frozen sap or moisture, the result of exceeding the minimum temperature is simply to delay the development of the embryo while this excess continues. There is an optimum moist temperature at which the germinating process is most active. This optimum differs with different species of plants. For most agricultural plants the maximum, minimum and optimum temperatures have been found by actual trial. These are given in the table on page 367, of this bulletin. The figures in this table are in part derived from the records of the N. C. Experiment Station. The figures, except as to flower seeds, have been compared with and in some cases modified to agree with similar tables published by Sachs, Nobbe, Stebler, and other European botanists and seed control stations. The figures for flower seeds, as given in the table, were furnished by the late Peter Henderson, of New York. Owing to the more pressing claims of other work the testing of flower seeds has not been carried far enough at this station to enable us to furnish trustworthy figures wholly from our own records. So far as we have gone, however, we found that Mr. Henderson's optimum temperature was from 5°F. to 10°F. too low, and in making up the table as given his optimum was in all cases increased by 5°F. The following are Sachs' minimum, maximum and optimum temperatures for germinating the seeds named: (See Sachs' *Handbook of Experimental Physiology.*)

Kind of Seed.	Minimum.	Maximum.	Optimum.
Indian Corn	49°F.	105°F.	91°F.
Bean	49°F.	105°F.	91°F.
Pumpkin	52°F.	105°F.	91°F.
Barley	41°F.	100°F.	84°F.
Wheat	41°F.	108°F.	84°F.

To show the greater quickness with which the seed sprouts at higher than at comparatively lower temperature, Nobbe gives the following table. The figures in the different columns indicate number of days in which the seeds remained in the germinating pan before the rootlet appeared, at the different temperatures indicated:

Plant.	Days before seeds began to germinate at different temperatures.			
	40°F.	50°F.	60°F.	65°F.
Winter Wheat	6	3	2	1¾
Winter Rye	4	2½	1	1
Winter Barley	6	3	2	1¾
Spring Oats	7	3¾	2¾	3
Indian Corn	---	11¼	3¼	3
German Millet	---	11⅕	4¾	4
English Ray Grass	10	5½	3¾	3
Tall Oat Grass	9	7¾	4½	3
Timothy Grass	---	6½	3¼	3
Red Clover	7½	3	1¾	1
Lucerne	6	3¾	2¾	2
Hop-trefoil	10	7½	4	3½
Lathyrus Sativus	7	3½	2¾	2¼
Faba Vulgaris	7	6½	4¾	4¼
Vetch	6	5	2	2
Pea	5	3	1¾	1¾
White Lupine	5	3¼	---	---
Buckwheat	8	4½	3½	3

The above table shows that for all but three of the genera tested the seed may begin to germinate at a temperature below 40°F. Wheat, rye, barley and seeds of hardy trees, such as the maple, have germinated on cakes of ice and pushed their roots down into the frozen mass.

Haberlandt (*Landw. Versuch Stationen, Band, XVII., 104*) gives the following table showing the number of seeds of each species of plant named, out of a sample of 100 seeds in each case, which sprouted at the constantly maintained temperatures indicated. The moisture supplied to the seeds being in each case sufficient. A series of similar tests was made at the N. C. Experiment Station in 1890, using the Nobbe seed pan. The result in most cases was a lower per cent. of ger-

minated seeds, but as a whole did not differ greatly from Haberlandt's table, the difference noted appearing to be caused by lower grade seeds:

Plants.	Number of Seeds Out of 100 which Sprouted in Number of Hours at the Indicated Temperature.									
	60° F.		77° F.		88° F.		100° F.		111° F.	
	Seeds Sprouted.	In hours.	Seeds Sprouted.	In hours.	Seeds Sprouted.	In hours.	Seeds Sprouted.	In hours.	Seeds Sprouted.	In hours.
Wheat	100	56	100	32	100	48	0	....	0	....
Rye	100	56	100	32	100	80	0	....	0	....
Barley	100	72	92	72	24	144	0	....	0	....
Oats	100	80	100	48	100	80	0	....	0	....
Indian Corn	80	144	68	56	100	48	100	48	12	80
German Millet	100	120	100	48	100	48	100	48	92	72
Timothy	76	168	100	44	88	148	0	....	0	....
English Ray Grass	100	216	100	120	100	72	0	....	0	....
Spurry	100	24	100	32	100	32	60	144	0	....
Vetch	100	48	100	48	100	65	0	....	0	....
Horse Bean	100	120	100	56	100	70	0	..	0	....
Lupines	100	128	100	56	100	48	100	56	0	....
Lathyrus Sativus	100	56	100	24	20	120	0	....	0	....
Crimson Clover	100	32	100	24	100	24	100	24	0	....
Red Clover	100	32	100	24	100	24	100	24	0	....
Lucerne	100	32	100	24	100	24	100	24	0	....
Buckwheat	100	72	100	24	100	24	100	48	0	....
White Mustard	100	24	100	24	100	24	0	....	0	....
Cabbage, late	100	48	100	24	100	48	0	....	0	....
Raddish	100	32	100	24	100	32	100	48	36	96
Carrot	100	152	100	56	100	216	0	....	0	....
Sunflower	100	32	100	32	100	24	100	48	0	....
Poppy	100	24	100	48	12	152	0	....	0	....
Tobacco	100	192	100	108	88	168	0	....	0	....
Squash	100	168	100	52	100	48	100	32	50	72
Cucumber	76	216	100	96	100	32	100	48	60	120
Muskmelon	4	290	100	120	100	48	100	48	20	96
Flax	100	32	100	23	100	47	0	....	0	....
Hemp	100	80	100	62	100	48	100	32	100	48

6.—THE ACTION OF LIGHT AND ELECTRICITY UPON THE GERMINATION OF SEEDS.

That the action of direct sunlight is distinctly detrimental to the germination process has been long known. Ingenhouse, in the last century, exposed seeds of the same species to the full sun light and to various degrees of obscured light down to total darkness in a chamber rendered sufficiently moist and warm to germinate the seeds. In every case the seeds exposed to the strongest light sprouted most tardily, while those exposed in complete darkness sprouted soonest. The exclusion of direct light does not imply the absence of air and oxygen, which are necessary to plant activity at all times.

Many experiments have been made from the time of Ingenhouse to Sachs to discover whether or not electricity has any appreciable influence upon the germinating embryo, but in all cases the results have been negative or contradictory. At present this form of universal energy has no value or place in testing the viability of seeds.

7.—THE ACTION OF CHEMICALS UPON THE GERMINATION OF SEEDS.

The generally detrimental action of corrosive chemicals upon sprouted seeds is well known. In practice chemicals may be divided into four classes: (1.) Those which by their corrosive action aid the sprouting embryo to break the protective covering or testa of the seed. (2.) Those which, being poisonous to burrowing grubs or worms, protect the embryo from such depredators. (3.) Those which furnish easily assimilable nourishment for the young plantlet. (4.) Those which destroy the spores of molds already on the seeds. Alexander von Humboldt was the first to discuss and explain the beneficial action of chlorine upon the germination of seeds. (See *Anhang zu Florae Fribergensis*, 1793, p. 156.) Humboldt soaked seeds of peas, cress and other plants in a very dilute aqueous solution of chlorine acid. In this solution the seeds germinated in from six to seven hours, whereas in control tests with water the same varieties of seeds did not germinate inside of thirty-six to forty-eight hours. Water at 46° F. dissolves three times its volume of chlorine; the solubility decreases when the temperature is either above or below this point. Chlorine water of about one-tenth saturated strength, has been used by gardeners to hasten or assist the germination of tender seeds in hotbeds and greenhouses. The chlorinated water is simply sprinkled on the soil after the seeds have been planted. To obtain the beneficial effect of chlorine water, it should be used only in soils free from iron compounds and other heavy metals, since chlorine combines freely with these elements.

The other halogens, iodine and bromine, have much the same action upon seeds as chlorine.

Sulfur in small quantities has a favorable influence upon germinating seeds. Its favorable action is probably due to its destroying the spores of molds upon the seed or in contact with it in the ground or seed-pan.

Arsenic has an energetic and very detrimental action upon germinating seeds.

Antimony has much the same action as arsenic.

The salts of the metallic elements are generally detrimental to the germinating seed. A 5 per cent. aqueous solution of iron sulfate (copperas) will destroy the germs of most seeds soaked in it until saturated.

When the iron salt solution is poured upon sand and seeds afterward sown therein, it requires a 11 per cent. solution to show the evil effects.

Oxid of manganese seems without positive action. Zinc oxid, in a 10 per cent. solution, has a retarding influence upon most seeds.

Lead salts seem wholly without action upon seeds. Bismuth salts are injurious to germinating seed. Copper salts are injurious in all cases and even in very dilute solutions. One gram of copper sulfate in one litre of water (about 15 grains to one quart) retards the germination of most seeds, especially legumines, and in most cases destroys the germinative capacity of one-third or more of the sample. A much more dilute solution is poisonous to the rootlets of recently sprouted plants. Nobbe found that wheat seed, which sprouted 100 per cent. in pure water, in a $\frac{1}{10}$ per cent. solution of copper sulphate gave only 7 per cent., and in a $\frac{1}{2}$ per cent. solution gave no sprouted seeds. With rye he got slightly better results, it requiring a 1 per cent. solution to kill all the seeds.

A 10 per cent. solution of hydrochloric acid in water seems to favor the quick germination of seeds which have been soaked in it for not over two hours. A longer soaking, *e. g.*, 24 hours, or a stronger solution, seems to destroy the life of the embryo.

Commercial sulfuric acid diluted with 16 times its volume of water has a favorable effect upon most seeds soaked therein for 10 to 12 hours. Clover and rape seeds are among those most susceptible to injury by this acid. Nitric acid is detrimental to the life of the embryo. Phosphoric acid, diluted with fifty times its volume of water, has a favorable action upon germinating seed. Oxalic acid, diluted to less than 7 per cent., is noxious to the seed. Tartaric acid, diluted to 2 per cent., is not unfavorable to the seed. Citric acid is unfavorable. Acetic acid is unfavorable when diluted with less than 400 times its volume of water. Tannic acid, diluted with 1,000 volumes of water, is favorable. Humic acid, diluted with 150 volumes of water, is favorable.

Carbonate of ammonia, when diluted with less than 300 volumes of water, is noxious to the germinating seed. Chlorid of potassium seems not to affect the embryo, but is favorable to the growing plant. Nitrate of potash diluted to less than $\frac{1}{300}$ is injurious. Bichromate of potassium in dilution of $\frac{1}{2000}$ destroys the germinating power of all seeds. Acetate of potassium diluted to less than $\frac{1}{5000}$ has an injurious effect.

Nitrate of soda diluted to $\frac{1}{8}$ acts favorably upon the germinating seed. Sulfate of soda, diluted to a 11 per cent. solution, seems without positive action on seeds. Chlorid of soda in a 11 per cent. solution seems favorable to some species of seeds, but is unfavorable to the cereals and others.

Sulfate of lime (gypsum) acts favorably on seeds. Carbonate of lime seems in all cases to act favorably. Nitrate of lime, diluted to $\frac{1}{50}$, acts unfavorably upon seeds of crucifers.

Sulfate of magnesia, diluted to $\frac{1}{100}$, gives good results with oats. Sulfate of baryta also gives good results with oats.

The oils, ethers, alcohol, and solutions of alkaloids act unfavorably.

8.—THE SPECIFIC GRAVITY OF SEEDS.

The specific weight of seeds is their weight compared with that of an equal volume of water. The specific gravity of seeds varies with the stage of growth and with the amount of endosperm in the seed.

The specific gravity of the proximate constituents of seeds are as follows:

Starch	1.53	Fat	0.90–0.96	Ash, about	2.50
Sugar	1.60	Legumin	1.28–1.36	Water	1.00
Parenchyma	1.53	Protein	1.29	Air	0.0012

It is apparent from these figures that an increase in the mineral constituents of the seed will increase its specific gravity far more than an equal volume of organic matter.

Immature and withered seeds are of less specific gravity than mature seeds of the same kind, because in the former the cells remain empty or are filled with water and air.

The following table of specific gravity of well-ripened seeds is given by C. F. Renz in an inaugural dissertation at Tubingen, as quoted by Nobbe in *Handbuch der Samenkunde:*

Kind of Seed.	Specific Gravity.	Kind of Seed.	Specific Gravity.
Abies pectinata, Fir	0.833	Hordeum hexastichon, 6-rowed barley	1.350
Acer pseudo-plantanus, Maple	0.630	Hordeum vulgare, Common barley	1.351
Agrostemma githago, Cockle	1.233	Lactuca sativa, Lettuce	1.043
Agrostis Mexicana, Mexican Bent	1.100	Larix Europæa, Larch	0.848
Allium sibericum, Onion	1.184	Linum usatissimum, Flax	1.163
Amygdalus communis, Peach (pit)	1.033	Lithospermum officinale, Gromwell	1.223
Anchusa officinalis, Buglass	0.923	Medicago sativa, Lucerne	1.337
Aquilegia vulgaris, Columbine	1.220	Nicotiana rustica, Tobacco	1.095
Arrhenatherum avenaceum, Tall oat grass, with awn	0.600	Nicotiana tabaccum, Tobacco	1.046
Avena sativa, Oat	1.345	Panicum miliaceum, Common millet	1.179
Avena nuda, Tartarian oat	1.314	Papaver sominiferum, Poppy	1.142
Beata vulgaris, Beet	0.536	Phaseolus communis, Bean	1.298
Betula alba, White birch	0.588	Phleum pratense, Timothy grass (cleaned)	1.022
Brassica campestris, Field cabbage	1.110	Pinus pinea, Stone pine	1.070
Brassica napus, Turnip	1.134	Pinus sylvestris, Scotch pine	0.807
Brassica præcox, Kohl rabi	1.143	Pisum sativum, Pea (large)	1.355
Bromus erectus, Upright brome	0.323	Pisum sativum, Pea (small)	1.324
Bromus inermis, Hungarian brome	0.746	Pyrus malus, Apple (seeds)	1.145
Canna Indica, Canna, Indian shot	1.365	Quercus robur, Oak (minus cup)	0.969
Cannabis sativa, Hemp	0.945	Ricinus communis, Castor bean	0.902
Carpinus betulus, Hornbeam	1.147	Rosa canina, Dog rose (seeds)	1.075
Chrysanthemum coronarium	0.770	Salvia officinalis, Sage	1.060
Cucumus sativa, Cucumber	1.041	Triticum vulgare, Wheat (sum'r)	1.337
Cucumus melo, Pumpkin	0.890	Triticum vulgare, Wheat (wint'r)	1.333
Datura stramonium, Jamestown weed	1.033	Triticum spelta, Spelt (cleaned)	1.347
Fagopyrum esculentum, Buckwheat	1.104	Triticum spelta, Spelt (in hull)	1.081
Holcus lanatus, Velvet grass	0.301	Vicia faba, Horsebean	1.298
Hordeum distichon, 2-rowed barley	1.317	Zea mays, Indian corn	1.147

The foregoing table shows that the highest specific gravity is found among the legumines, next rank the cereals, rich in starch. Free seeds generally have a low specific gravity. The oily seeds come next, and lightest of all are the seeds of composite plants. The limits within which the specific gravity of the same species may vary have been determined for wheat by O. Wolfenstein, who tested some thirty samples from different sources with the following results:

VARIATION OF VOLUME AND SPECIFIC GRAVITY IN WHEAT.

VARIETY.	SOURCE.	SHAPE.	COLOR.	Vol. of 100 seeds, in cubic centimeters.	Wt. of 100 seeds in grams	Specific gravity.
Wheat, White	Germany	Long-oval	Grayish yellow	2.306	3.107	1.400
Wheat, Summer	Germany	Round-oval	Brownish yellow	2.106	2.865	1.388
Wheat, English (?)	Germany	Longish	Brownish yellow	2.638	3.671	1.391
Wheat, Tuscan	Australia	Long-oval	Whitish yellow	3.984	5.650	1.415
Wheat, Purple Straw	Australia	Oval	Whitish yellow	4.725	6.671	1.397
Wheat, Siberian (?)	Australia	Long, like rye	Gray brown	1.567	2.159	1.414
Wheat, Michigan Amber	Michigan	Longish	Yellow brown	2.482	3.513	1.429
Wheat, Ohio Red	Ohio	Long-oval	Yellow brown	2.420	3.460	1.439
Wheat, Trit. Vulg. dur.	Tiflis	Long, 3-edged	Yellow brown	3.627	5.155	1.405
Wheat, Trit. Vulg. dur.	Hungary	Long, 3-edged	Yellow brown	2.209	3.086	1.427
Wheat, Mixed, average	Germany	Long-oval	White yellow	2.290	3.240	1.376
Wheat, Trit. Vulg. Turg.	Denmark	Roundish	White yellow	2.519	3.553	1.406
Wheat, Trit. Vulg. Turg.	Jutland	Oval	White yellow	2.744	3.853	1.397

9.—THE VOLUME WEIGHT OF SEEDS.

In the table of specific gravity, page 371, the specific gravity stands in no definite relationship with the volume, or "Dutch" weight. The volume weight is obtained by weighing in the air the contents of a standard measure, such as the bushel or the hectolitre. This weight is more or less influenced by the shape and size of the seeds which permit the seeds to form a more or less compact mass, and also by the shape of the vessel.

The volume weight of cereal seeds of the same harvest varies considerably: Wheat, from 100 to 155; oats, from 100 to 137; barley, 100 to 131; rye, 100 to 123. Small sized or withered seeds give a smaller volume weight than large plump seeds. The number of seeds in any measure increases with the volume weight and the weight of the individual seeds decreases in like ratio. With cereal seeds the absolute weight of the individual seeds invariably increases with the volume weight. Chemical analyses show that the higher the volume weight the better the edible quality of cereal or starchy seeds.

The following examples are given by A. Muller, quoted by Nobbe, *Handbuch der Samenkunde*, p. 322:

1.—WINTER RYE.	*Sample A.*	*Sample B.*
Specific gravity	1.39	1.39
Hectolitre weight	77.0	62.4 kg.
No. seeds per hectolitre	2,817,606	4,537,215
Average weight per seed	25.8	12.9 mg.
Volume of each seed	18.6	9.3 c. mm

2.—Winter Wheat.	*Sample A.*	*Sample B.*
Specific gravity	1.39	1.39
Hectolitre weight	86.9	55.9 kg.
No. seeds per hectolitre	2,403.583	3,993,903
Average weight per seed	30.2	13.2 mg.
Volume of each seed	23.1	9.5 c. mm

3.—White Oats.	*Sample A.*	*Sample B.*	*Sample. C.*
Specific gravity	- --	----	----
Hectolitre weight	62.6	54.2	45.7 kg.
No. seeds per hectolitre	1,944,016	1,744,822	1,547,073
Average weight of each seed	30.5	29.2	27.9 mg.

The foregoing examples show that the heavier the seeds, the greater the percentage of water and starch, and less of the other constituents, except in case of oats, in which the heavier seeds have a greater per cent. of protein.

In example 2—winter wheat—chemical analysis, according to A. Muller, shows that in purchasing one hectolitre each of the heavier (A) and lighter (B) samples, we would obtain the following quantities of the food-stuffs named:

	Sample A.			*Sample B.*	
Volume of weight	86.90 kilogram.			55.90	kilogram.
Water	13.60	kilogram	per hectolitre.	8.70	"
Crude fibre	2.21	"	"	3.38	"
Ash	1.37	"	"	1.01	"
Protein	10.28	"	"	7.25	"
Fat	2.27	"	"	1.33	"
Sugar	1.22	"	"	1.34	"
Starch	55 95	"	"	32.89	"
Total	86.90	"	"	55.90	"

The heavier seeds have a greater amount of endosperm, or food material, than the lighter, but it does not follow that the capacity to sprout, or the viability, is greater in heavier than in lighter seeds, or that the heavier seeds will produce the more vigorous plants. Prof. Nobbe gathered from a pine tree at successive periods from August 1 to November 1, 1,314 seeds of specific gravity less than 1, and 542 seeds of specific gravity greater than 1. Of the first class 70.3 per cent. germinated; of the second class only 1.3 per cent. germinated. For ordinary consumption, too, a sample of grain of lighter volume-weight may give better results than a heavier sample, as is shown in the case of spring wheat, which, although heavier than winter wheat, is worth less in the market. Winter barley has less volume weight than spring barley, but in breweries winter barley is preferred. Cereal seeds which have a very thick and hard coat, or testa, have a heavier volume-weight, but are of less value to the miller, brewer, and feeder, than thinner-skinned and lighter seeds. In many cases it is also easy to mix heavy fraudulent matter with seeds, thus increasing the volume-weight of sample. For these and other

reasons the volume-weight of seeds must be regarded as only one of several factors in determining the real value of seeds offered in the market. The more prudent way is therefore in all cases to purchase only after an actual test of sample, including determination of the purity and viability, as well as specific gravity and volume-weight.

10.—THE LIFE OF THE PLANT EMBRYOS.

During the development and life of the embryo in the seed we can distinguish three stages of progress, which may be designated respectively the (A) harvest stage, (B) the germinating stage, and (C) the inert stage.

A.—The Harvest Stage.

The first stage is characterized by the dissolution of the organic connection between the seed and the mother plant. The second stage is reached when the seed becomes capable of germinating under suitable environment. The third stage is reached when the viability of the embryo becomes extinct.

As soon as the fertilization of the ovule has been accomplished, the development of the embryo and the formation of endosperm in the embryo sack begins. The complete development of the embryo may take from a few days or weeks to years. With most agricultural plants the whole process is completed in from two to four weeks after fertilization of the ovule. The process of blooming, and consequently the ripening of the seeds, is longer continued in the centripetal than in the centrifugal floration. For example, rye, *secale cereale*, centrifugal inflorescence, ripens all of its seeds in from six to eight days after flowering; whereas, buckwheat, *Fagopyrum esculentum*, centripetal inflorescence, continues to ripen its seeds for some months.

As soon as the embryo, or "kernel," has developed its enveloping sack, and the food reserve, or endosperm, has been built up, the water contents of the seed rapidly decreases, and the seed becomes in consequence considerably crumpled and contorted, causing rupture of its organic connection with the mother plant. The seed is then "harvest ripe." It derives no more nourishment from the mother plant, and during its further connection the mother plant merely affords an asylum for the seed.

B.—The Germination Stage.—Seed Viability.

It is well known that even with many species of plants, when well ripened and normally developed seeds are planted, these may remain a long time in the seed-bed before germinating. Such seeds have small vital energy. Among the kinds of seed showing the extremes of vitality, we may name the clovers, the crucifers, and most cereals. In these seeds the harvest ripeness and germination ripeness are

scarcely distinguishable apart. Such seeds germinate well within twelve hours after the "harvest ripeness" stage occurs. On the other hand we find that most tree seeds require several months before the seed, under the most favorable surroundings, will germinate.

The common opinion that with the clover, cereals, flax and other seeds whose harvest-ripe and germination-ripe stages fall nearly or quite together are benefited by being kept for some time before again being sown is a mere prejudice not borne out by the facts as shown by careful tests. In many cases sound and viable seeds are delayed in sprouting by an impermeable seed coat, whereby the absorption of water and oxygen, and the consequent swelling of the seed, the first step in the germinating process, is prevented. This is well known in the case of seeds of the pulse tribe of forage plants and with many leguminous trees. Among the slowest seeds to sprout are sanfoin, serradella, and kidney vetch. Professor Nobbe took 300 seeds of sanfoin, removed the hulls from 100 and placed them in the germinating apparatus along with 100 seeds with hulls on, and 100 similar to the last he put between sheets of moist blotting paper. The following were the results:

	Days required for the given number of seeds to germinate.									Total. Per Cent.
	3	4	6	8	10	12	14	16	19	
100 unhulled seeds in apparatus	1	10	23	20	11	8	6	6	1	86
100 unhulled seeds in blotting paper	0	12	25	22	--	15	2	1	1	78
100 hulled seeds in apparatus	21	20	12	15	9	12	0	0	1	90

In practical seed-testing in the laboratory, as an average of many tests, the following is given as the time in which more than one-half the seeds used, may be expected to sprout:

The cereals, clovers, opium, poppy, crucifers, spurry, vetchlings, vetches, and peas, three days.

Cucurbits, beans, flax, spinach, buckwheat, and timothy grass, four days.

Oats, tall oat grass, canary grass, meadow fescue, and ray grasses, five days.

Red top, sanfoin, beet, carrot, and others, six days.

Meadow fox tail, yellow oat grass, sweet vernal, peas, Cynosurus, Dactylis and remainder of fescues, seven days.

When at the conclusion of a six day's germinating test of leguminous seeds, some seeds remain hard, it is certain that under ordinary favorable circumstances a portion of these will eventually germinate. After much experience in seed-testing, the German seed control stations have fixed upon one-third as the number of hard seeds of this family to be counted as viable after enduring unaltered a germinating trial of twelve or fourteen days. As regards other seeds, especially forest tree and flower seeds, a careful microscopic examination of

sections of the hard seeds must be made to determine whether or not the embryo is normally developed and sound, and of those in which the embryo appears normal and sound one-third, should be counted as viable in calculating the real worth of the sample.

The following table is compiled mainly from the records of the N. C. Experiment Station. Some of the figures are taken from foreign sources:

TABLE SHOWING NUMBER OF DAYS BEFORE ONE-HALF A SAMPLE MAY BE EXPECTED TO SPROUT.

SCIENTIFIC NAME.	COMMON NAME.	No. of days before first germination	No. of days before one-half sample germinated.
GRAMINEÆ:			
Zea mays	Indian corn	3	4— 5
Alopecurus pratensis	Meadow foxtail	4—5	7— 8
Phleum pratense	Timothy	2—3	4
Phalaris canariensis	Canary grass	1—2	5— 6
Holcus lanatus	Soft velvet grass	4—5	6— 7
Anthoxantum odoratum	Sweet vernal grass	5—6	7— 9
Agrostis stolonifera	Fiorin	4—6	6— 8
Avena sativa	Oats	1—2	5— 6
Arrhenatherum avenaceum	Tall meadow oat grass	3—4	5— 6
Poa pratensis	Kentucky blue grass	5—6	7— 8
Poa trivialis	Rough stalked mead. grass	5—6	7— 8
Cynosurus cristatus	Crested dog's tail grass	5—6	7— 8
Dactylis glomerata	Orchard grass	5—6	7— 8
Festuca ovina	Sheep's fescue	4—5	7— 8
Festuca pratensis	Meadow fescue	3—4	5— 6
Festuca rubra	Red fescue	4—5	7— 8
Pennesetum spicatum	Pearl millet	3—4	4— 6
Lolium perenne	English ray grass	3	5— 5
Lolium Italicum	Italian ray grass	3	5— 6
Sorghum sp.	Sorghums	2	4— 8
Triticum vulgare	Wheat	1—2	3— 4
Secale cereale	Rye	1—2	3— 4
Hordeum vulgare	Barley	1—2	3— 4
LILIACEÆ:			
Allium cepa	Onion	2—3	5— 6
CONIFERÆ:			
Picea vulgaris	Silver fir	3—5	7— 9
Pinus sylvestris	Scotch pine	4—5	7— 9
Pinus austriaca	Black pine	4—5	7— 9
Abies pectinata	Fir	9—10	15—20
Larix Europæa	Larch	5—6	10—13
CHENOPODIACEÆ:			
Spinacia oleracea	Spinach	1—2	4— 5
Beta vulgaris	Beet	3—4	6— 7
POLYGONACEÆ:			
Fagopyrum esculentum	Buckwheat	2—3	4— 5
Rumex patientia	Patience dock	2—3	4— 5
PLANTAGINEÆ:			
Plantago lanceolata	English plantain	½—1	3— 4
COMPOSITÆ:			
Chicorium indiva	Endive	1—2	3— 4
Helianthus annuus	Sunflower, mammoth	2—3	5— 7
Achillea milfolium	Yarrow	2—3	4— 8
Lactuca sativa	Lettuce	1—2	3— 4

TABLE SHOWING NUMBER OF DAYS, ETC.—*Continued.*

SCIENTIFIC NAME.	COMMON NAME.	No. of days before first sprout.	No. of days before one-half sample sprouted.
SOLANACEÆ:			
Lycopersicum esculentum	Tomato	3—4	6— 8
Solanum melongena	Egg plant	4—5	9—10
Capsicum annum	Pepper	3—7	10—12
UMBELLIFERA:			
Apium graveoleus	Celery	6—7	10—12
Petroselinum sativum	Parsley	3—6	9—11
Pastinaca sativa	Parsnip	....	.....
Daucus carota	Carrot	3—4	6— 7
PAPAVERACEÆ:			
Papaver somniferum	Opium poppy	1—2	3— 4
Papaver rhœas	Garden poppy	1—2	2— 4
CRUCIFERÆ:			
Lepidium sativum	Cress	½—1	2— 3
Brassica, sp.	Cab'ge, turnip, must'd, etc.	½—1	2— 3
Raphanus sativa	Radish	½—1	2— 3
CUCURBITACEÆ:			
Cucurbita pepo	Pumpkin	2—3	4— 5
Cucumis sativus	Cucumber	2—3	4— 5
Cucumis melo	Muskmelon	2—3	4— 5
Citrullus vulgaris	Watermelon	2—3	4— 6
CARYOPHYLLACEÆ:			
Spergula arvense	Spurry	2	3— 4
LINACEÆ:			
Linum usitatisimum	Flax	1—2	4— 5
PAPILIONACEÆ:			
Anthyllis vulneraria	Kidney vetch	1	2— 3
Medicago sativa	Lucerne	½—1	2— 3
Medicago media	Sand lucerne	½—1	2— 3
Medicago lupulina	Hop-trefoil	½—1	2— 3
Medicago maculata	Spotted medic	½—1	2— 3
Melilotus leucantha	Bokhara clover	1—2	3— 4
Trifolium pratense	Red clover	½—1	2— 3
Trifolium repens	White clover	½—1	2— 3
Trifolium hybridum	Alsike clover	½—1	2— 3
Trifolium incarnatum	Crimson clover	2—3	.....
Lotus corniculatus	Birdsfoot trefoil	2—3	5— 6
Lathyrus sativus	Vetchling	2—3	2— 3
Lathyrus odoratus	Flat pea	2—3	3
Vicia sativus	Vetch	2—4	3
Vicia faba	Horsebean	2—3	.....
Glycine hispida	Soy, or soja pea	2—3	4— 5
Pisum sativum	Garden pea	1—2	3— 4
Phaseolus vulgaris	Bean	1—2	3— 4
Phaseolus radiatus	Japan red bean	2—3	4— 5
Dolichos sinensis	Cowpea	1—2	3— 4
Ervum lens	Lentil	2—3	4— 5
Ornithopus sativus	Serradella	3—4	5— 6
Onobrychis sativa	Sanfoin	3—4	6— 7
Lupinus luteus	Yellow lupin	2	4— 5

C.—The Inert Stage.

The length of time during which a normally developed seed will under ordinary circumstances retain its viability, is a matter of the very greatest importance to all who handle or use seeds. No definite rule for general application can be laid down. There is a popular prejudice in favor of recently harvested seeds. As everybody wants "fresh seeds" the seedsmen are often tempted to handle immature and undeveloped seeds which, while in truth "fresh," are nevertheless of very feeble viability or wholly inert.

Long experience from results at this and foreign stations in seed testing, has furnished the following data as to the number of years during which normally developed and well ripened seeds of the sorts named will, under ordinary favorable conditions, retain their viability: Wheat, 3 years; other cereals, millet and most grasses and clovers, 2 years; cabbage, turnip, rape, 3 years; mustard, hemp and flax, 4 years. The viability of most forest tree seeds is extremely fugacious. With the seeds of the majority of the more common forest trees, under ordinary circumstances, the embryo retains its vitality no longer than the spring succeeding the year they were ripened. The oak, beech, maple and fir are such trees. Still shorter is the life of seeds of the poplar, willow and elm. These latter seeds must be sown or bedded as soon as ripe, as they become inert in a few days. The life of pine and spruce seeds has a three years' duration, and the larch three or four years.

Although seed vitality is in general so feeble there is no good reason why seeds, fully developed and preserved under the most favorable circumstances, should not remain dormant and viable for an indefinite period or for more than a century. The so-called Talevera wheat is reported on respectable authority to have been derived from a seed found in an Egyptian tomb. Seeds of *Centaurea cyanus*, *Helitropium vulgare* and *Trifolium minimum*, found in a sealed casket in an old tomb at Mountjoy, St. Denis, in France, have reproduced the above named plants. This tomb dated back to the third or fourth century of the Christian era, and the genuineness of the find has never been disproved.

Charles Moulins (*Comtes Rendu Soc. Linn. de Bordeaux*, VII., 1835) reports having, during some archeological researches, found at a depth of eight feet, among articles dating back to the period before the conquest of Gaul by the Romans, seeds which sprouted and reproduced the plant *Mercurialis annua*. Many botanists have germinated seeds taken from herbarium specimens labelled for several decennials, and in at least one case from a specimen of *Echium vulgare*, known to be 300 years old.

These indisputable evidences of longevity of dormant seeds gives us cause to hope that when the various factors concerned in developing the seed embryo and conserving its viability are better known, the term "old seeds" will have lost its terrors.

In practical agriculture it is necessary to recognize the fact that the seeds of the market are very apt to lose the capacity to germinate after a period, varying for different genera of plants, but comparatively short for all.

The greatest difficulty in the way of determining the duration of the life of the seed embryo, under ordinary commercial usage, is to obtain old seeds of known age and a sufficiently great age to give the maximum limits.

The following table is given in Nobbe's *Handbuch*. The succeeding table is reprinted from Bulletin 67*a* of the N. C. Experiment Station. These series of tests are much too short to be wholly trustworthy, but may be taken so far as they go as approximately correct:

TABLE SHOWING VIABILITY OE SEEDS KNOWN TO BE AT LEAST TEN YEARS OLD.

FAMILY.	GENERA.	COMMON NAME.	Per Cent. of Viable Seeds.	REMARKS.
Gramineæ	Zea mays	Indian corn	10	Two samples; 3 samples gave 0.
Gramineæ	Triticum vulgare	Wheat (Kensingt'n)	10	Several other varieties gave 0.
Gramineæ	Sorghum vulgare	Sugar cane	0	Samples from Japan Austria and Egypt.
Gramineæ	Panicum echinatum	Spring panic grass	3	Other panicums gave 0.
Urticaceæ	Cannabis sativa	Hemp	0	
Compositeæ	Chicorium intybus	Chicory	35	From Egypt.
Caryophyllaceæ	Spergula arvense	Spurry	41	Eleven years old.
Solonaceæ	Lycopersicum esculentum	Tomato	20	
Cruciferæ	Sinapsis Pekinensis	Chinese mustard	5	
Cruciferæ	Brassica napus	Turnip	0	
Cruciferæ	Brassica campestris, var.	Rape	30	
Cruciferæ	Brassica campestris, var.	Russian kubja rape	40	
Cruciferæ	Brassica campestris, var.	Rutabaga	27	
Malvaceæ	Abutilion avicennæ	Cottonweed	15	
Linaceæ	Linum usitatissimum	Flax	14	Sample from Egypt; another sam. gave 0.
Legumineæ	Trifolium hybridum	Alsike clover	1	Two per cent. of sample remained hard.
Legumineæ	Medicago media	Sand lucerne	12	
Legumineæ	Various genera	Bokhara and crimson clover, sanfoin, serradella, horseb'n	0	
Legumineæ	Vicia sativa	Brown vetch	14	Several other samples [gave 0.
Legumineæ	Pisum sativum	Garden pea	24 30 55	Three samples; several gave 0.
Legumineæ	Dolichos, several species	Closely related to the cowpea.	0	
Legumineæ	Lupinus termis	Roman lupine	0	
Legumineæ	Phaseolus vulgaris	Comm'n bush bean	0	Several samples.
Legumineæ	Phaseolus sativus		75	One other sample gave 0.

TABLE SHOWING VIABILITY OF SEEDS KNOWN TO BE SIX OR SEVEN YEARS OLD.

COMMON NAME.	Per Cent. of Viable Seeds.
Sunflower, small Russian	0.
Sunflower, large Russian	21.
Gourd, Southern	20.
Pea, garden	0.
Pea, garden	7.
Bean, large lima	0.
Bean, marrowfat	0.
Sanfoin	0.
Millet, golden	1.
Millet, Hungarian	0.
Clover, mammoth	1.
Timothy grass	0.
Randall grass	2.
Rye grass, Italian	1.
Meadow foxtail	0.
Johnson grass	1.
Castor oil bean	5.
Oats, rust proof	83.
Oats, black	71.
Buckwheat, silverhull	0.
Rice	13.
Barley	14.
Cotton	0.
Wheat, flint	0.
Wheat, Fultz	0.
Wheat, Caldwell's rust proof	0.

These tables show that for the longest-lived seeds, under ordinary mercantile practice, 10 years is about the maximum limit, while for the large majority of such seeds the limit is below six years.

To learn how rapidly the devitalizing process progresses, Prof. Nobbe made annual tests from the same packages of various seeds from 1870 to 1874, with the following results:

Flax, average of 13 samples, 1870—72.3 per cent.; 1872—54.3 per cent.; 1873—46.9 per cent.; 1874—38.5 per cent.

Spurry, average of 7 samples, 1871—89 per cent.; 1874—85 per cent.

Red clover, average of 32 samples, 1870—87 per cent.; 1872—70 per cent.; 1873—53 per cent.; 1874—43 per cent.

Pea, average of 21 sampls, 1871—96 per cent.; 1873—88 per cent.

Turnip, average of 6 samples, 1870—77 per cent.; 1872—59 per cent.

Mustard, average of 2 samples, 1870—86 per cent.; 1872—76 per cent.

Rye, 1 sample, 1870—100 per cent.; 1872—87 per cent.; 1875—26 per cent.

Timothy grass, average of 23 samples, 1870—83 per cent.; 1872—67 per cent.; 1873—53 per cent.; 1875—46 per cent.

Soft velvet grass, average of 5 samples, 1871—39 per cent.; 1874—22 per cent.

Fiorin grass, average of 4 samples, 1871—21 per cent.; 1874—20 per cent.

Meadow fescue grass, 1 sample, 1871—26 per cent.; 1874—9 per cent.

Sheep's fescue, average of 3 samples. 1871—21 per cent.; 1874—7 per cent.

Red fescue, average of 8 samples, 1871—23 per cent.; 1874—6 per cent.

Austrian pine, average of 8 samples, 1871—60 per cent.; 1874—30 per cent.

The above table shows that the decrease of viability is not generally so rapid as has been supposed. But many of the seeds which germi-

nated under the wholly favorable conditions arranged by Nobbe would have failed to sprout in the field, or would have produced feeble and worthless plants.

In testing old seeds, along with the constantly decreasing viability percentage, we find also an obvious qualitative deterioration. Old seeds are always characterized, according to their age, by loss of their original color and lustre. Such seeds, too, even when the cotyledous or shoot axis emerges from the seed in the sprouting pan are apt to have a malformed root axis or none at all, rendering them practically unviable. Seeds rich in oil and protein appear to deteriorate more rapidly than starchy seeds. Of course in considering the progressive deterioration shown in the foregoing tables, it must be remembered that in the beginning, as the sample tested was small and each year grew smaller, the figures for different years are not exactly comparable.

III. PRACTICAL SEED TESTING.

1.—VIABILITY, PURITY, AND GERMINATION OF SEEDS.

For the economical purchase of seeds, there are four fundamental points to be considered, viz.:

1.—Whether the seeds are the species desired.

2.—Whether they are of at least average volume-weight.

3.—Whether the sample is free from deliberate adulteration and from noxious impurities.

4.—Whether the sample possesses a high percentage of viable seeds and high vital energy, as shown by the rapidity with which germination takes place.

In purchasing seeds in the market we cannot expect to obtain the highest possible quality or 100 per cent. of "real worth"; 100 per cent. is the ideal standard of measurement and at best we can only hope to approximate it. Agricultural seeds giving 95 per cent. "real worth" may be considered of very high grade, because from necessity these seeds are grown, cured and handled in a wholesale way by machinery, and are always more or less mixed with dirt, trash and foreign seeds.

The percentages of purity and viability that may be reasonably looked for in good marketable seeds are given in the table on page 383, *et seq.* These figures are made up by combining the average results obtained in testing seeds during a series of years in this country and Europe. The viability percentage is that possible under artificially favorable circumstances, as in ordinary laboratory seed testing, where the degree of temperature, moisture, etc., are fully under control and are varied to suit different classes of seeds. The viability percentage found in laboratory testing is always higher than in ordinary field practice, because in field practice the amount of moisture, heat, light and oxygen are either not at all or only in a small degree under control.

To estimate the *Real* or *Agricultural Worth* of a seed sample, we must combine the purity and viability percentages, thus:

$$\frac{\text{Viability} \times \text{Purity}}{100} = \text{Real or Cultural Worth in terms of per cent.}$$

We must also consider the nature of the foreign constituents of the sample. If we have a sample of Red clover in hand, it is a very important matter, from a practical standpoint, to know whether the impurities present are timothy and other useful seeds, or seeds of dodder, plantain, wild carrot, and other noxious weeds.

The table following gives, in a condensed form, the average percentages of purity and viability that extensive series of microscopic

examinations and germinating tests have shown choice seeds to possess. The last three columns give the maximum, minimum, and optimum temperatures for germinating these seeds. The data for this table has been collated from the records of the North Carolina Experiment Station, and several other American stations, as well as from very complete reports received from the French National Station in Paris, the Swiss Station at Zurich, the Kiel Station in Germany, and the Danish Station in Copenhagen. The late Peter Henderson furnished from his own experience a very full set of figures as to purity and viability, and many other American and foreign seedsmen have furnished valuable data which has been incorporated into this table. This table does not assume to give the figures for the highest possible grade of seeds, but only for choice merchantable seed. Seed falling more than 5 per cent. in cultural value below these figures cannot be called choice. The real or cultural worth of the different species is found in terms of per cent., by multiplying the purity by the viability and dividing by 100, as shown on the preceding page.

TABLE SHOWING VIABILITY AND PURITY OF GOOD COMMERCIAL SEEDS, AND TEMPERATURE AT WHICH THEY GERMINATE.

KIND OF SEED.	VIABILITY, PER CENT.	PURITY, PER CENT.	GERMINATING TEMPERATURE.		
			Max. °F.	Min. °F.	Opt. °F.
GRASSES AND CEREALS:					
Agrostis stolonifera (fiorin)	82.0	71.1	95	60	75
Agrostis vulgaris (red top)	72.0	97.4	95	60	75
Alopecurus pratensis (meadow foxtail)	42.0	83.5	95	60	75
Authoxantum odoratum (sweet vernal)	30.0	85.7	95	60	75
Authoxantum puelli (annual sweet vernal)	26.0	83.7	95	60	75
Arrhenatherum avenaceum (tall oat grass),	69.0	68.1	95	60	75
Avena sativa (com. oat)	95.0	97.5	90	55	70
Avena flavescens (yellow oat grass)	37.0	42.5	95	60	75
Bromus mollis (soft chess)	46.0	64.4	90	55	70
Bromus inernis (Hungarian brome)	81.0	76.3	90	55	70
Bromus pratensis (meadow brome)	61.0	77.4	90	55	70
Bromus schraderi (rescue grass)	70.0	95.0	90	55	70
Cynodon dactylon (Bermuda grass)	52.0	98.5	95	65	80
Cynosurus cristatus (crested dogstail)	62.0	89.1	95	60	75
Dactylis glomerata (orchard grass)	81.0	73.9	95	60	75
Festuca duriuscula (hard fescue)	67.0	86.7	95	60	75
Festuca elatior (Randall grass)	83.0	85.4	95	60	75
Festuca tenuifolia	60.0	71.4	95	60	75
Pestuca ovina (sheep's fescue)	71.0	80.3	95	60	75
Festuca pratense (meadow fescue)	81.0	86.9	95	60	75
Festuca rubra (red fescue)	48.0	73.1	95	60	75
Holcus lanatus (velvet grass)	39.0	68.2	95	60	75
Hordeum vulgare (cult. barley)	82.0	97.9	95	50	65
Lolium Italicum (Italian rye grass)	73.0	93.0	95	50	75
Lolium perenne (English rye grass)	76.0	94.3	95	50	75
Oryza sativa (cult. rice)	85.0	97.1	95	65	80
Panicum germanicum (golden millet)	88.0	97.5	95	65	80
Panicum miliaceum (millet)	82.0	98.0	95	65	80
Panicum sanguinale (crab grass)	85.0	97.5	95	65	80
Penicillaria spicata (pearl millet)	82.0	98.0	95	65	80

TABLE SHOWING VIABILITY AND PURITY OF GOOD COMMERCIAL SEEDS—*Continued.*

KIND OF SEED.	VIABILITY, PER CENT.	PURITY, PER CENT.	GERMINATING TEMPERATURE.		
			Max. °F.	Min. °F.	Opt. °F.
GRASSES AND CEREALS—*Contiuued:*					
Phleum pratense (timothy)	89.0	97.6	95	60	75
Poa arachnifera (Texas blue grass)	60.0	88.5	95	60	75
Poa compressa (June grass)	70.0	80.8	95	60	75
Poa nemoralis (wood grass)	60.0	78.9	95	60	75
Poa pratense (Kentucky blue grass)	60.0	84.8	95	60	75
Poa serotina (fowl meadow grass)	75.0	83.5	95	60	75
Poa trivialis (rough stalked meadow grass)	55.0	85.0	95	60	75
Secale cereale (cult. rye)	91.0	99.0	90	55	75
Setaria Italica (Italian millet)	87.0	97.5	95	60	75
Sorghum halapense (Johnson grass)	75.0	95.0	99	65	80
Sorghum nigrum (sugar cane)	75.0	97.5	99	65	80
Sorghum saccharatum (broom corn)	75.0	97.5	95	60	75
Triticum vulgare (cult. wheat)	95.0	98.2	95	55	75
Zea mays (Indian corn)	95.0	98.5	100	65	85
FORAGE LEGUMINES:					
Hedysarum coronarium (sulla)	85.0	95.0	100	65	85
Lespedeza striata (Japan clover)	76.0	98.0	100	65	80
Melilotus alba (Bokhara clover)	87.0	97.0	100	65	80
Medicago lupulina (yel'w trefoil, nonesuch)	77.0	95.3	100	65	80
Medicago maculata (spot. medic, burr clov.)	90.0	95.0	100	65	80
Medicago media (sand lucerne)	80.0	96.2	100	65	80
Medicago sativa (lucerne)	88.0	97.5	100	65	80
Onobrychis sativa (sanfoin)	85.0	96.9	100	65	80
Ornithopus sativus (serradella)	95.0	96.7	100	65	80
Spergula arvense (spurry)	78.0	98.1	100	65	80
Dolichos sinensis (cowpea)	95.0	98.5	110	65	85
Trifolium hybridum (alsike clover)	73.0	95.4	95	60	75
Trifolium incarnatum (crimson clover)	89.0	97.3	100	65	80
Trifolium pratense (red clover)	91.0	96.7	95	60	80
Trifolium pratense, var-perenne (mammoth, or pea-vine clover)	93.0	96.7	95	60	80
Trifolium repens (white clover)	86.0	94.5	95	60	80
FIELD AND GARDEN CROPS:					
Asparagus	80.0	98.5	90	60	75
Beans, bush	90.0	99.5	90	60	75
Beans, lima	95.0	99.5	100	65	80
Beets	133.0	97.5	90	60	75
Broccoli	65.0	99.0	90	55	70
Brussels sprouts	89.0	99.0	90	55	70
Buckwheat, mammoth	92.0	98.8	90	55	70
Buckwheat, silverhull	82.0	98.8	90	55	70
Cabbage	89.0	99.0	90	55	70
Cauliflower	80.0	99.5	90	55	70
Carrot	59.0	90.5	90	55	70
Celery	32.0	99.0	90	55	70
Chicory	72.0	98.0	90	55	70
Cotton, upland	82.0	97.0	100	65	80
Cotton, sea island	80.0	97.0	100	65	80
Cucumber	86.0	99.0	100	65	80
Egg plant	60.0	99.0	100	65	80
Endive	94.0	97.0	90	55	70
Kale	95.0	98.5	90	55	70
Kohl rabi	88.0	98.5	90	55	70
Leek	55.0	98.5	90	55	70
Lettuce	77.0	98.0	90	55	70

TABLE SHOWING VIABILITY AND PURITY OF GOOD COMMERCIAL SEEDS—*Continued.*

KIND OF SEED.	VIABILITY, PER CENT.	PURITY, PER CENT.	GERMINATING TEMPERATURE.		
			Max. °F.	Min. °F.	Opt. °F.
FIELD AND GARDEN CROPS—*Continued:*					
Lupine, yellow	79.0	98.5	95	60	75
Melon, musk	90.0	99.0	100	65	80
Melon, water	89.0	99.0	100	65	80
Mustard	95.0	98.0	90	55	70
Okra	85.0	99.0	100	65	80
Onion	85.0	99.0	80	50	65
Parsnip	75.0	99.0	90	55	70
Parsley	70.0	98.5	90	55	70
Peanut	95.0	98.5	98	60	75
Pea, garden	97.0	99.0	80	50	65
Pepper	76.0	98.0	100	65	85
Pumpkin	85.0	98.5	100	65	85
Rhubarb	85.0	96.5	90	55	70
Radish	95.0	99 0	90	50	70
Sage	55.0	96.0	90	50	70
Salsify	83.0	98.0	90	50	70
Scorzonera	86.0	98.0	90	50	70
Spinach	89.0	98.0	90	50	70
Squash	90.0	99.0	100	65	85
Sunflower	85.0	99.0	100	65	85
Tobacco	88.0	99.0	90	60	70
Tomato	80.0	98.0	100	65	80
Turnip	94.0	99.0	100	65	80
Thyme	60.0	97.0	100	65	80
FLOWER SEEDS:					
Aquilegia	53.0	99.5	90	60	70
Canterbury bell	75.0	99.5	90	60	70
Carnation	68.0	99.5	90	30	70
Catchfly	85.0	99.5	90	60	70
Centaurea	68.0	99.5	90	60	70
Chrysanthemum, annual	65.0	99.5	90	60	70
Cineraria	60.0	99.5	90	60	70
Clarkia	70.0	99.5	90	60	70
Cobea	60.0	99.5	95	65	80
Clematis	50.0	99.5	90	60	70
Convolvulus	93.0	99.5	90	60	70
Coleus	68.0	99.5	95	65	80
Datura	78.0	99.5	95	65	80
Dahlia	70.0	99.5	95	65	80
Daisy, bellis	70.0	99.5	90	60	70
Digitalis	85.0	99.5	90	60	70
Dianthus	79.0	99.5	90	60	70
Dolichos, hyacinth bean	89.0	99.5	95	65	80
Evening primrose	70.0	99.5	95	65	80
Eschscholtzia	90.0	99.5	95	65	80
Gaillardia	80.0	99.5	90	60	70
Heliotrope	70.0	99.5	95	65	80
Hibiscus	70.0	99.5	95	65	80
Hollyhock	75.0	99.5	95	65	80
Larkspur	60.0	99.5	95	65	80
Lobelia	80.0	99.5	95	65	80
Lychnis	70.0	99.5	95	65	80
Marigold	89.0	99.5	95	65	80
Maurandya	70.0	99.5	95	65	80
Mimulus	75.0	99.5	95	65	80

TABLE SHOWING VIABILITY AND PURITY OF GOOD COMMERCIAL SEEDS—*Continued.*

KIND OF SEED.	VIABILITY, PER CENT.	PURITY, PER CENT.	GERMINATING TEMPERATURE.		
			Max. °F.	Min. °F.	Opt. °F.
FLOWER SEEDS—*Continued:*					
Pansy	66.0	99.5	95	65	80
Pyrethrum	69.0	99.5	95	65	80
Mignonette	70.0	99.5	95	65	80
Nemophila	84.0	99.5	95	65	80
Nigelia	65.0	99.5	95	65	80
Nasturtium	90.0	99.5	95	65	80
Portulaca	93.0	99.5	90	60	70
Poppy, garden	90.0	99.5	90	55	65
Phlox	63.0	99.5	90	55	65
Petunia	80.0	99.5	90	60	70
Primula (sinensis fimb.)	60.0	99.5	90	60	70
Ricinus	80.0	99.5	95	65	80
Salvia	70.0	99.5	90	60	70
Scabiosa	85.0	99.5	90	60	70
Stock	75.0	99.5	90	60	70
Sweet pea	75.0	99.5	80	50	65
Sweet William	70.0	99.5	90	60	70
Verbena	70.0	99.5	90	60	70
Vinca	70.0	99.5	95	65	80
Violet	68.0	99.5	90	60	70
Zinnia	90.0	99.5	95	65	80

2.—SEEDS, THEIR IMPURITIES AND ADULTERATION.

THE GRASS FAMILY.



Fig. 4. VELVET GRASS. *a.* and *b.* spikelet; *c.* caryopsis and sterile flower obive; *a.* natural size.

Bermuda grass seed is all imported. It is generally very clean, as this grass does not permit other plants to grow with it.

Crested dog's-tail grass seed is nearly all imported from Europe, and generally contains more or less seeds of velvet grass (*Holcus lanatus*), shown at Fig. 4, and blue pearl grass (*Molina caerula*), shown at Fig. 5. Both of these are worthless weeds, and the latter grass is dangerous to the health of stock which eat it. Sheep's fescue seeds are also used to adulterate samples of crested dog's-tail.

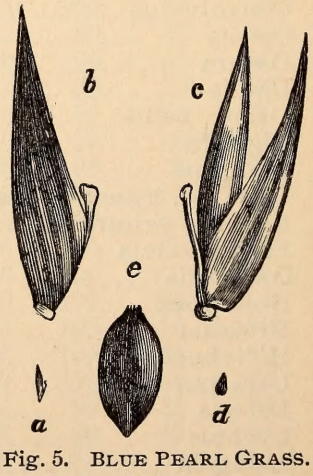


Fig. 5. BLUE PEARL GRASS. *a. b. c.* spikelet; *d. e.* caryopsis; *a.* and *d.* natural size.

Tall fescue seed is frequently adulterated with seeds of English rye grass, a useful but much cheaper seed. To the uncritical eye these two kinds of seeds are very difficult to distinguish. Fig. 6 shows seeds of tall fescue; Fig. 7 seeds

of English rye grass. It will be observed that the stalk at the base of the fescue seed is long, slender, and the top is nearly circular in outline. In the case of the rye grass the stalk is short and thick, and decreases in diameter from the top to the bottom, and the top is nearly oval in outline. The other fescue grasses are not generally adulterated, but sheep's fescue (*F. ovina*) is frequently sold under the name of red fescue. It is quite impossible for anyone but an experienced botanist to distinguish the seeds of the true red fescue from those of sheep's fescue. The dealer should be required to specially guarantee the genuineness of his red fescue seed, to be determined best by analyzing a specimen of the grass produced by the seed.

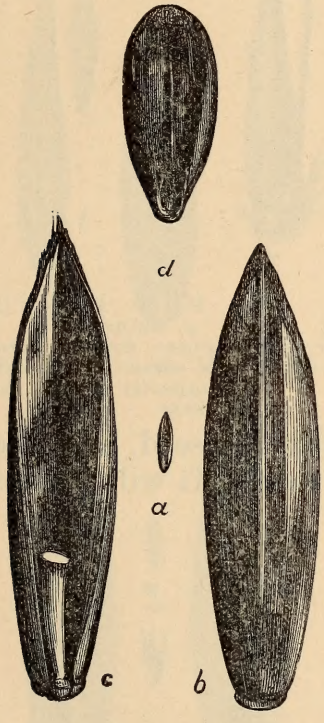


Fig. 6. MEADOW FESCUE GRASS.
a. flower, natural size; *b*. *c*. same magnified—front and back views; *d*. naked caryopsis.

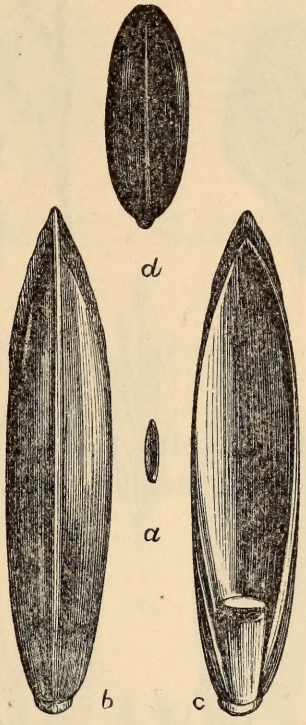


Fig. 7. ENGLISH RYE GRASS.
a. flower, natural size; *b*. and *c*. same magnified; *d*. caryopsis.

Fowl meadow grass seed is often mixed with seeds of buttercup (*Ranunculus bulbosus* and *repens*, Fig. 8), and with seeds of various aquatic weeds. Seeds of rough-stalked meadow and red-top grasses are also usually present, but these are good seed and do not injure the quality of the sample.

Johnson grass seed, as sold, is not usually mixed with any other, but uncleaned seed is often very foul with chaff and straw.

Kentucky blue grass is not, as a rule, adulterated, and seldom contains other grass seeds as impurities. The one most often found is tufted hair-grass (*Aira caespitosa* and *A. flexuosa*, Fig. 9). "Uncleaned" blue grass seed usually contains from 20 to 30 per cent. of its weight in chaff and the woolly hairs found attached to the base of the seed. The "extra-cleaned" grade of this seed should be always purchased. It is the cheapest.

Meadow fox-tail grass seed comes chiefly from Europe. Samples are very frequently adulterated with seeds of velvet grass (Fig. 4), which bear some resemblance to the true fox-tail seed. A compari-

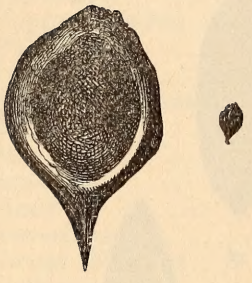


Fig. 8. BUTTERCUP.



Fig. 9. HAIR GRASS.
a. c. d. flower, back and side views; *e.* and *f.* caryopsis; *a.* and *e.* natural size.



Fig. 10. RESCUE GRASS.
a. natural size. *Rescue grass*, *Bromus unioloides*, is sometimes found as an impurity in oats, and *vice versa*.

son of Fig. 4 with Fig. 11, true meadow fox-tail seed, will show the different appearance of the two kinds of seed. It will be observed

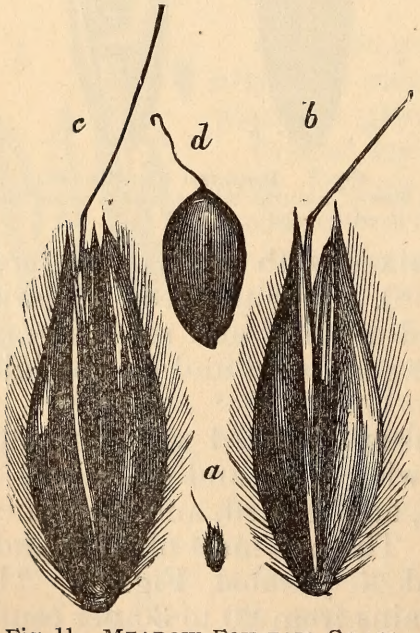


Fig. 11. MEADOW FOX-TAIL GRASS.
a. b. c. spikelet; *d.* caryopsis; *a.* natural size.

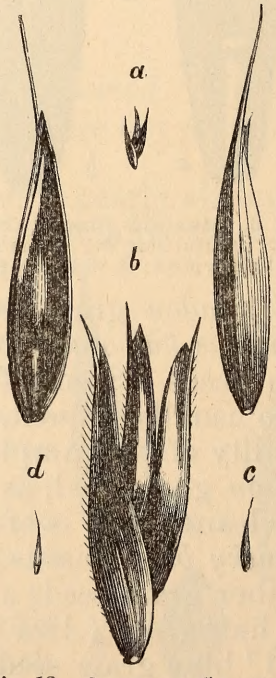


Fig. 12. ORCHARD GRASS.
a. natural size; *a. b.* spikelet; *c. d.* flowers.

that the exterior glumes or husks of velvet grass have short, thick and hooked awns, whereas true fox-tail seed has only one awn, which

is long and slender and bent in the middle. The seeds of creeping fox-tail grass (*Alopecurus agrestis*) are not infrequently substituted for meadow fox-tail. These are harder to detect. The edges of meadow fox-tail seeds have abundant and rather long soft hairs. Those of creeping fox-tail have only a few short and stiff hairs. The seeds of true fox-tail are softer, whiter and flatter than those of the creeping species.

Orchard grass seed is not commonly adulterated, but when sold in the uncleaned state the sample often contains one-fifth of its weight in chaff, dirt, and various weed seeds. The most common of these

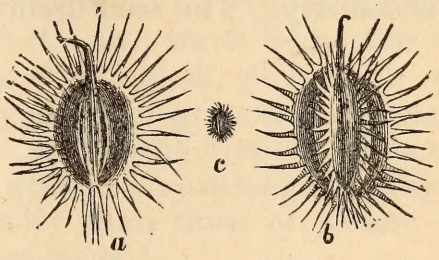


Fig. 14. WILD CARROT.
c. natural size; *a*. *b*. front and edge views.

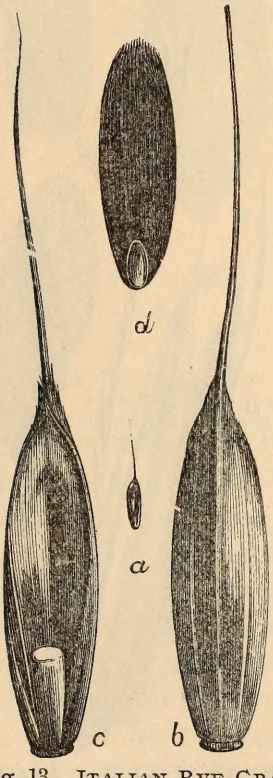


Fig. 13. ITALIAN RYE GRASS.
a. natural size; *a*. *b*. *c*. flower—front and back views; *d*. caryopsis.

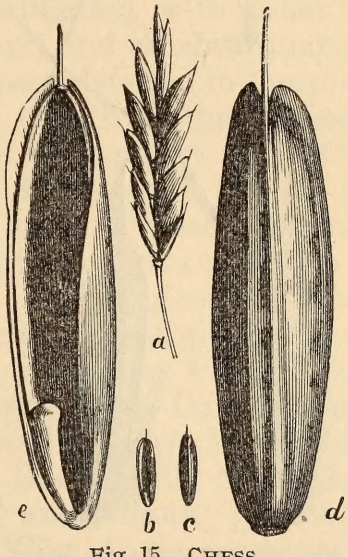


Fig. 15. CHESS.
a. spikelet; *b*. *c*. flower—front and back view; *a*. *b*. *c*. natural size.

weed seeds are ox-eye daisy (*Chrysanthemum leucanthemum*), carrot (*Daucus carota*), dog fennel (*Maruta cotula*) and knot weeds (*Polygonum*). When deliberately adulterated, the seeds most commonly employed for this purpose are those of sheep's fescue. Seed imported from Europe is apt to contain also seed of blue pearl grass (Fig. 5) and seeds of several species of brome grass (Fig. 15).

English rye grass seed is not usually adulterated, as it is itself one of the cheapest seeds in the market. The samples come chiefly from England and Scotland, where rye grass is the prevailing herbage of wet meadows. Badly cleaned samples are apt to contain a good deal of velvet grass (Fig. 4) and soft brome grass (*Bromus mollis*), plantain (*Plantago lanceolata*), and buttercup (*Ranunculus*, Fig. 8).

Italian rye grass seed is not infrequently adulterated with seed of English rye grass, which is a cheaper seed. Fig. 7 shows English rye grass seed. Fig. 13 shows Italian rye grass seed. The latter is awned; the former is not. The stalk at the base of Italian rye grass seed is more slender than that at the base of English rye grass seed.

Red-top seed is not usually adulterated. Uncleaned samples are apt to contain seeds of timothy, fowl meadow and other moist land grasses, as well as seeds of sedges, buttercup (Fig. 8) and divers bog weeds.

Rough-stalked meadow grass is not extensively sold in the market in this country. The seed used is chiefly imported from Europe, where

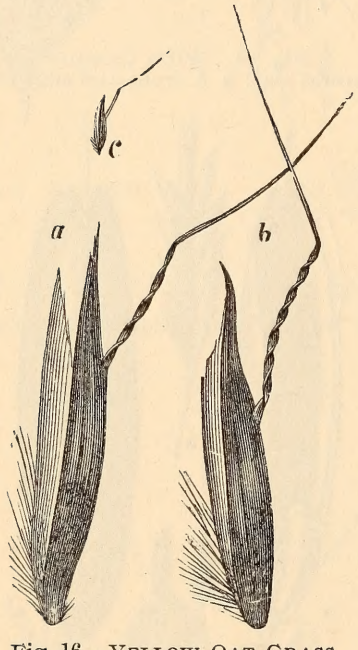


Fig. 16. YELLOW OAT GRASS.
c. natural size; *a. b. c.* flowers.

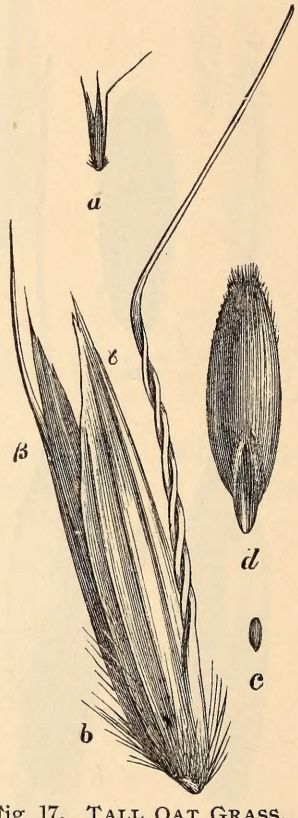


Fig. 17. TALL OAT GRASS.
a. b. spikelet; *c. d.* caryopsis; *a.* natural size.

this species is esteemed above its sister species, our Kentucky blue grass. The latter species is therefore apt to be used to adulterate samples of the former, and they are rather difficult to distinguish. The seeds of rough meadow grass (*Poa trivialis*) have a bluish tinge, are more slender than those of Kentucky blue grass, and have fewer woolly hairs at the base and on the back. Other and worthless species of annual *Poas* are also used to debase samples of rough meadow grass seed. Blue pearl grass (Fig. 5) is used for the same purpose.

Sweet vernal grass seed is nearly all imported from Europe. This seed is one of the most expensive handled by the trade, and the temptation to adulterate is consequently great. The annual variety (*Anthoxantum puelli*) is not infrequently substituted altogether for the true

perennial species. These two kinds of seeds are very difficult to distinguish. The annual seeds are lighter colored, and the husks are shorter than is the case with the true perennial species. Other impurities in samples of this seed are sheep's fescue, hair grass (Fig. 9), ox-eye daisy and various weeds common on poor soil.

Tall oat grass is not usually adulterated, but badly cleaned samples are apt to contain a good deal of chess grass (*Bromus secalinus* and *racemosus*, Fig. 15). Samples imported from Europe are apt to contain seeds of yellow oat grass (Fig. 16), which is, however, a good grass, and of poison darnel (*Lolium temulentum*), which is a dangerous weed. Fig. 17 shows the true tall meadow oat grass. It will be observed that the awn starts from near the base of the husk, whereas in case of yellow oat grass the awn starts from above the middle. The tall oat grass seeds are longer and more slender than those of yellow oat grass seeds.

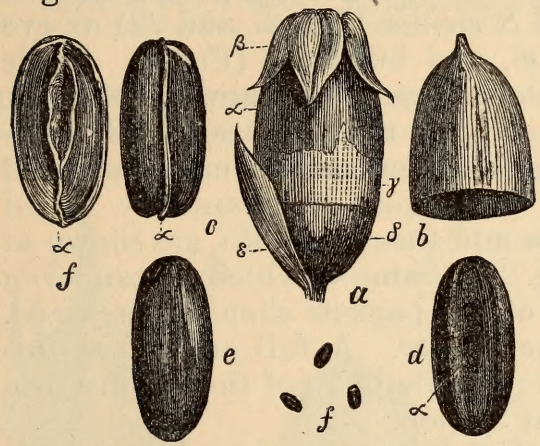


Fig. 18. PLANTAIN.
a. fruit, with attached corolla; B. the four corolla petals; *c*. twin seeds; *d*. the inner surface of seeds; *e*. back of seed; *f*. seed, natural size.

Timothy grass seed is not usually adulterated with other seeds, but sand and crushed quartz rock have been detected in samples. As a rule, timothy is the cleanest seed sold in the market. "Uncleaned seed," however, is likely to include seeds of weeds common on moist soils—plantain (Fig. 18), dock, buttercup, etc., and also seeds of Kentucky blue grass. Pigeon grass (*Setaria glauca* and *viridis*, Figs. 21 and 22) are also present in uncleaned samples of timothy.

Fiorin seed is nearly all imported from Europe, where this grass is found chiefly in parks and woodland pastures. Commercial seed is obtained principally from the latter, and is apt to be mixed with seeds of weeds found in such places. Dog's tooth bent (*Agrostis canina*), tufted hair grass (*Aira cæspitosa*) and timothy (*Phleum pratense*) are the most common impurities. When fiorin grass is allowed to become over-ripe before harvesting, the seed shatters out very readily, and in commercial samples a large proportion of the glumes or seed husks contain no seed. Sand and dirt are always present in uncleaned samples, which is difficult to remove, because, as the seed is so light, in running through a fanning-mill a large proportion is blown away. The same holds good of *Poa trivialis* and *P. serotina*.

The Clover Family.

The clovers are the most frequently adulterated, and generally the foulest samples found in the markets. Crushed quartz rock, either plain or colored, to resemble true seed, has been frequently employed where dealers do not fear detection. Old, discolored and worth-

less seeds are often dyed and mixed with fresh seed. These "doctored" seeds can be detected by pouring some of the seed upon a clean white cloth, slightly moistened, and rubbing the seeds thereon. The cloth will remove the artificial coloring and show it. Quartz grains can be readily detected by examining the seeds with a magnifying-glass. "Uncleaned" samples often contain one-fifth of their weight in weed seeds, the most common of which are plantain (*Plantago lanceolata*, Fig. 18), sheep's sorrell (*Rumex acetosella*, Fig. 19), chick weed (*Cerastium triviale*, Fig. 20), pigeon grass (*Setaria glauca* and *S. viridis*, Figs. 21 and 22), ox-eye daisy, dog fennel, and buttercup (Fig. 8). Seeds of a parasitic plant commonly known as dodder, "devil's-gut" and "gold thread," are usually present in samples of clover and lucerne imported from Europe. These plants, botanically called *Cuscuta epilinum* and *Cuscuta trifolii*, are shown at Fig. 23 and Fig. 24. Samples which contain even a trace of seeds of this parasite should be rejected, whatever be their price. A full account of this weed was given in Bulletin 70 of the North Carolina Experiment Station.



Fig. 19. SHEEP'S SORRELL. *a*. seed in hull; *b*. naked seed; *c*. natural size.

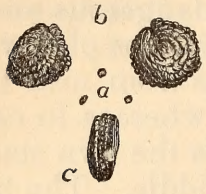


Fig. 20. CHICK WEED. *a*. natural size; *b*. magnified; *c*. same in profile.

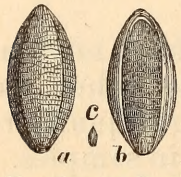


Fig. 21. GREEN PIGEON GRASS. *a*. *b*. back and front views, enlarged; *c*. natural size.

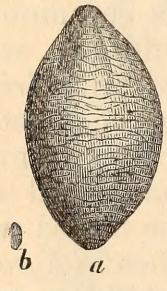


Fig. 22. YELLOW PIGEON GRASS. *a*. magnified to show marking; *b*. natural size.



Fig. 23. FLAX DODDER. *a*. natural size; *b*. magnified; *c*. double seeds.

Alsike clover (Fig. 25) seed is largely imported from Europe, and is apt to contain dodder seed (Fig. 25—on the ground), which, being of nearly the same size as the clover seed, is very difficult to get rid of. Uncleaned samples are more or less infested with seeds of buttercup (Fig. 8), plantain (Fig. 18), sheep's sorrell (Fig. 19), and chick weed (Fig. 20)

Crimson clover seed is generally much cleaner than other clovers, and the samples are not frequently adulterated. The most common impurities are plantain (Fig. 18), ox-eye daisy, and sheep's sorrell (Fig. 19).

Japan clover is usually sold in the husk, and is not adulterated. Neither does it contain as impurities other kinds of seed, for Japan clover permits no other plant to grow among it. Samples are, however, often very dirty with sticks, stones and trash. In dry seasons the seeds do not fill well. Good seed should weigh 24 pounds per bushel.

Lucerne seed is largely imported from Europe, and is apt to contain dodder (Figs. 23 and 24), plantain (Fig. 18), common pimpernel (*Pimpinella saxifraga*, Fig. 26), and seeds of composite weeds. American-grown seed samples are apt to contain seeds

of hog weed (*Amarantus spinosus*), dog fennel, and pigeon grass (Figs. 21 and 22). European lucerne seed is generally better than American-grown seed. The best comes from Provence, in France.

Red clover seed is not now imported from Europe. The most com-



Fig. 24. CLOVER DODDER. *r*. section of seed; *c*. endosperm; *v*. vegetation point.

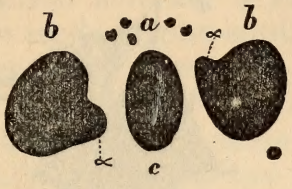


Fig. 25. ALSIKE CLOVER. *a*. natural size; *b*. side view, showing rootlet; *c*. profile view.

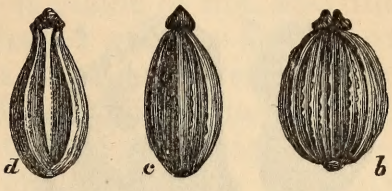


Fig. 26. COMMON PIMPERNEL. *b*. double fruit; *c*. *d*. single fruit, back and front view, enlarged.

mon adulterants are quartz grains, which can be detected by using a magnifying-glass. Uncleaned red clover seed is probably the foulest seed on the market. The most common impurities are plan-

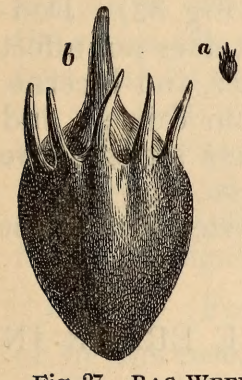


Fig. 27. RAG WEED, HULLED SEED, WITH PAPPUS. *a*. natural size.

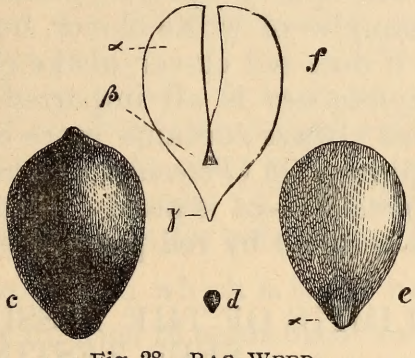


Fig. 28. RAG WEED. *c*. without pappus and cut open; *d*. natural size; *d*. *e*. naked seed; *f*. section of seed, showing cotyledons.

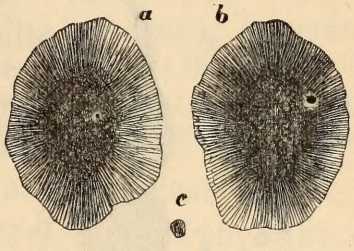


Fig. 29. RANSTED WEED. *a*. *b*. front and profile views; *c*. natural size.

tain (Fig. 18), sheep's sorrell (Fig. 19), pigeon grass (Figs. 21 and 22), rag weed (*Ambrosia artemisæfolia*, Figs. 27 and 28), ransted weed (*Linaria vulgaris*, Fig. 29), corn cockle (*Agrostemma githago*, Fig. 30),

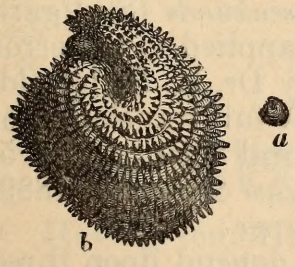


Fig. 30. CORN COCKLE. *a*. natural size; *b*. magnified.

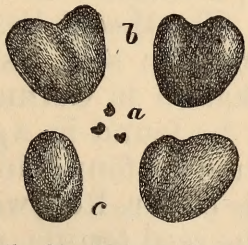


Fig. 31. WHITE CLOVER. *a*. natural size; *b*. side views, showing rootlet; *c*. profile.

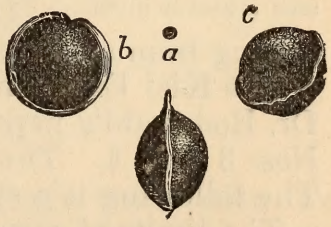


Fig. 32. SPURRY. *a*. natural size; *b*. *c*. *d*. different views, magnified.

dog fennel, ox-eye daisy, and wild carrot. Dodder (Fig. 24) is also apt to be present in samples of red clover, though not so often as with lucerne. The least trace of dodder should condemn the sample.

White clover seed (Fig. 31) is, to some extent, imported from Europe, and is sometimes adulterated with old and dead seed, colored and

"doctored" with sulphur to resemble fresh seed. Quartz grains, either plain or colored, are used for the same purpose. The most common impurities in badly cleaned samples are plantain (Fig. 18),

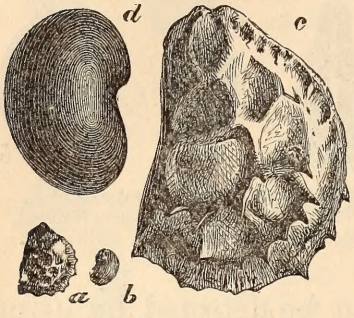


Fig. 33 SANFOIN.
a. c. hulled seed; *b. d.* naked seed; *a.* and *b.* natural size.

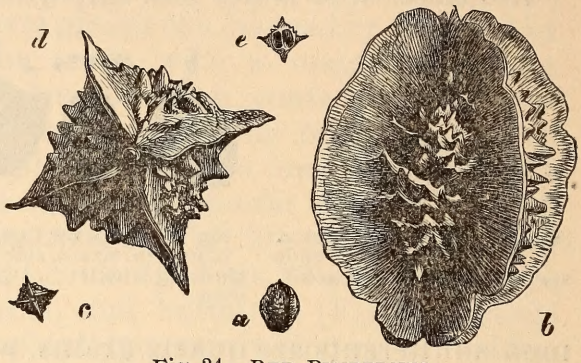


Fig. 34. RED PIMPERNEL.
a. b. c. d. different views of the fruit; *e.* section of fruit, showing two seeds; *a. c. e.* natural size.

sheep's sorrell (Fig. 19), and spurry (*Spergula arvensis*, Fig. 32). Dodder may be present in samples of white clover, but it does not affect this species as much as it does red clover, alsike clover, and lucerne.

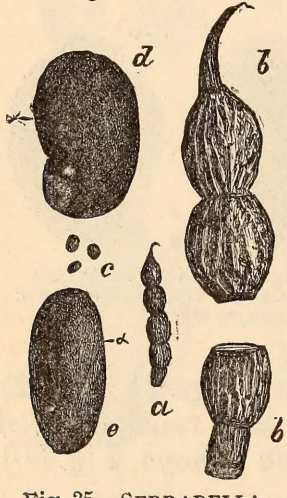


Fig. 35. SERRADELLA.
a. b. loments; *c. d.* naked seed; *e.* seed in profile.

Sanfoin seed is all imported from Europe, and almost always contains more or less seeds of the red pimpernel (*Poterium sanguisorba*, Fig. 34).

Serradella seed is nearly all imported, and is apt to be infested by red pimpernel.

3.—LIMITS OF THE POSSIBLE ERROR IN SEED TESTING.

In all kinds of analytical work—chemical as well as physiological—it is customary to allow a margin for possible error, whose limits are defined by the mathematical law of chances. The general theory is ably and exhaustively discussed by Jordan, *Handbuch der Vermessenkunde* (Stuttgart, 1888). The theory has been applied to the error arising from subjective causes in seed testing, by Dr. H. Rodewald, of the Kiel Experiment Station in Germany. A full translation of Dr. Rodewald's paper can be found in Agricultural Science, Vol. 5, Nos. 3 and 4. The original is found in *Versuchs Stationen*, 1889. The following is a synopsis of Dr. Rodewald's paper:

The limits of error in the seed testing process depend upon three different factors, viz.: 1. The apparatus and method used. 2. The execution of the process. 3. Pure accident. The last factor is the most important. The apparatus and method must be assumed to be the best attainable at the time, and can be improved as experience allows. Where a uniform apparatus and method are used by all public and private stations, the errors arising from this cause neutralize each other, and the relative or comparative value of the work

is not affected. The execution of the process must be assumed to be in the hands of competent experts, or the value of the work is *nil.* The error of pure accident arises from selecting particular seeds in separating the sample for testing. As a general rule, one cannot tell by mere visual inspection whether a seed is viable or not, and the viable and non-viable seeds in non-sophisticated samples are mixed together without order or arrangement. It depends, therefore, upon pure accident whether the ratio of the viable to the non-viable in the sample separated for testing is the same as that in the entire sample. Error of this kind falls under the law of chances, and is the only error of which mathematical theory can take cognizance.

If by any competent method we undertake to separate the viable from the non-viable seeds in a sample, the viability of each seed taken alone will be either 1 or 0. It depends upon the quality of the sample how often 1 or 0 appears. From a series of such observations we take the arithmetical mean as the average viability of the sample in terms of per cent. The greater the number of terms in the series, the closer will the arithmetical mean approximate to the true viability of the sample. It follows from this proposition that we can form a table in which, for each per cent. of viability from 0 to 100, the theoretical error is contained, and the agreement between the theoretical and the true error will be greater as we take for the test 100, 200, 300, or more seeds. The mathematical theory gives the following algebraic formula for calculating the mean error (m):

$m=\sqrt{\frac{v\,v}{n-1}}$ (Formula 1), in which n is the number of observations, or, in this case, the number of seeds used; $v\,v$ is the sum of the square of the variation from the arithmetical mean.

Example: Suppose we have a sample of 5 seeds, whereof 1 fails and 4 germinate, we may form the following table:

Seed.	Viability.	Variation from arithmetical means.	Square of the variation.
1st seed	1	$+\frac{1}{5}$	$\frac{1}{25}$
2d "	1	$+\frac{1}{5}$	$\frac{1}{25}$
3d "	1	$+\frac{1}{5}$	$\frac{1}{25}$
4th "	1	$+\frac{1}{5}$	$\frac{1}{25}$
5th "	0	$-\frac{4}{5}$	$\frac{16}{25}$
			$v\,v=\frac{20}{25}$

Therefore, $m=\sqrt{\frac{\frac{20}{25}}{5-1}}=0.447$.

Having found the average error of each single observation, we may then ask, How large is the mean error of the arithmetical mean of n observations? Representing this error by M, we get the following equation:

$$M=\frac{m}{\sqrt{n}}$$ (Formula 2.)

This equation is very important, since it shows that the mean error of the arithmetical meandiminishes as the number of observations in the series increases.

Where we use only five seeds in a germinating test, and from the result—4+0 good seeds—the arithmetical mean of these five tests be taken as the viability of the sample, the possible error due to chance amounts to 13.48 per cent. Once in four or five trials this error is liable to be doubled. Once in twenty-two trials the error may be trebled, or 40.44 per cent., and so on. In practical work such uncertainty is wholly impermissible. But, as Formula 2 shows, the possible error decreases as the square root of the number of observations increases. By increasing, therefore, the number of seeds taken for the test, the possible error may be made as small as we wish.

Theory shows that the probable error becomes inconsiderably small only when we use over 400 seeds. On the other hand, we must remember that subjective errors—those due, for instance, to miscounting—increase as the number of seeds increase, and therefore it is not advisable to exceed the number of 400. Nobbe, in his *Handbuch der Samenkunde* (Berlin, 1876, p. 508), says: "It is important that a minimum of 200 seeds, an optimum of 400, or a maximum of 600 seeds, should be used for each test if we wish to ascertain the true quality of a sample." It speaks well for the acumen of this investigator that he, by the empirical method, should have discovered the exact number which the theory of probability shows to be the best.

Using always, then, 400 seed (200+200) for the test, we may calculate the possible error due to accident—an error which is unavoidable, even in the most careful work. For example, when the apparent viability lies between 90 and 95 per cent., the possible error lies between 1.02 and 0.74 per cent. But when the apparent viability is 50 per cent., the error is 1.69 per cent., in round numbers 1.7 per cent. The error will also be doubled once in 3.4 to 4.6 cases; will reach 5.1 per cent. once in 22 cases; 6.8 per cent. once in 142 cases; 8.5 per cent. once in 1,341 cases, and so on.

If the apparent viability of a sample is 50 per cent., one may calculate that in 22 tests the allowable latitude of 5 per cent. will be once exceeded, but where the viability is 95 per cent. a variation of 4.4 per cent. will occur only once in 19,230 cases.

A very extensive series of practical germinating tests—over one thousand—made at the Kiel Station, has shown that the error as found by the empirical method follows the theoretical law. The agreement is particularly close in regard to clover and similar seed and awnless grasses, while it is much less close with awned seeds, as the latter do not mix so readily or thoroughly. Errors larger than the theory indicates, are usually to be ascribed to defects in the apparatus or execution of the tests.

Below is given the latitudes for different degrees of guaranteed viability, in the case wherein the exactitude is such that the latitude is theoretically liable to be exceeded only once in 22 trials:

Apparent viability. Per cent.	Latitude allowable for error.	Variation allowable between the two parallel tests. Per cent.
100	0	0
95	2.22	4.62
90	3.06	6.49
80	4.08	7.62
70	4.65	9.78
60	4.98	10.38
50	5.07	10.65

These latitudes refer to guaranteed and found viability of 400 seed sample; the variation refers to two parallel tests of 200 seeds each. If we multiply the variation by two, we get the number of sprouted seeds by which one of the duplicated tests may exceed the other, and yet remain a trustworthy test. If we divide the 400 seeds into four equal parts and test each 100 seeds separately, the variation allowable between the different tests may be greater, according to the following table:

Apparent viability. Per cent.	Allowable variation between duplicated tests. Per cent.
100	0
95	6.57
90	9.04
80	13.06
70	13.82
60	14.77
50	15.08

If the variation between any two parallel tests is greater than given above, the tests are unreliable, but within the limits given the variation does not vitiate the test.

The foregoing calculations show that Nobbe argued correctly when he said that a latitude of 5 per cent. between guaranteed and found viability was the maximum allowable for a viability of 50 per cent., and that between parallel trials of 200 seeds each a difference of more than 10 per cent. vitiates the test. Theory gives the allowable difference as 10.65 per cent. When the viability falls below 50 per cent., the permissible latitude falls in the same ratio as from 50 to 100 per cent., so that for a viability of 40 per cent. the latitude is the same as for one of 60, and so on down to 0 per cent., which has the same latitude as 100 per cent.

In practice it will not be necessary to employ all the latitudes herein discussed. Probably the most satisfactory way is to use, for all samples having a viability of 90 per cent. and over, a latitude of 3 per cent.; for all samples below 90 per cent. use the 5 per cent. latitude advised by Nobbe.

4.—METHODS AND APPARATUS USED IN SEED TESTING.

A. Germinating Apparatus.

In testing seeds the most important piece of apparatus is the germinating pan. Of this there are several forms in use, the best known of which are here described, beginning with the oldest form.

1. THE NOBBE GERMINATING PAN.

This consists of a square of porous baked clay, about 8 x 8 inches and $1\frac{1}{2}$ inches thick. The bottom and the sides for about $\frac{1}{2}$ inch above the base are glazed on outside. On the surface of this square is sunk a ring or fosse 1 inch deep and 1 inch wide. This fosse surrounds a circular space of about $4\frac{3}{4}$ inches in diameter, which has a concave surface, forming a shallow dish about 4 inches in diameter.

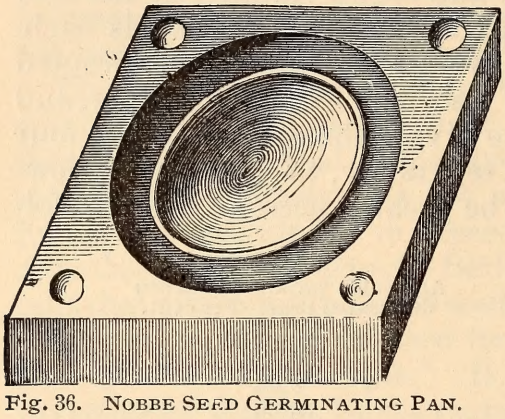


Fig. 36. NOBBE SEED GERMINATING PAN.

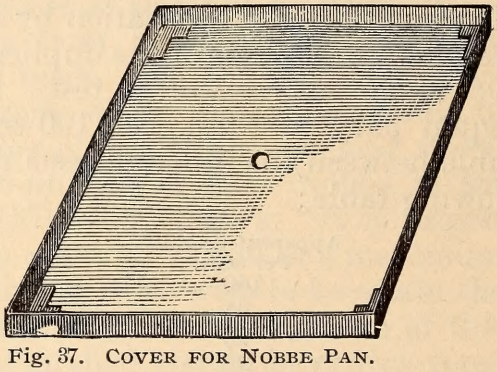


Fig. 37. COVER FOR NOBBE PAN.

Over the whole is fitted a cover having a central orifice of about $\frac{1}{4}$ inch diameter for ventilation. The seeds are placed in the central dish, water is then poured into the fosse, the cover is placed on, and the whole pan set away in a suitably heated and darkened chamber.

The Nobbe pan gives good satisfaction when one has plenty of room and facilities for supplying different temperatures, but for general use it is too cumbrous, and, with ordinary facilities, is inconvenient for germinating seeds requiring different temperatures. This pan is made in Germany, and is sold by Paul Parey, of Berlin. The cost laid down in New York, duty free, is about $12 per dozen.

2. THE ZURICH PAN.

This consists essentially of a round porous plaster disc, about 2 inches in thickness, having a shallow depression on the surface, a little larger than the central dish in the Nobbe pan. This pan, with others, when in use, are sunk to nearly the rim in moist sand contained in a metallic outer pan or case, which has a cover. The sand is kept moist by sprinkling it with water, and is heated by gas-jets underneath, the flow of the gas being regulated by means of a thermostat. This is a great improvement upon the Nobbe pan, as regards compactness. It is much less cumbrous, and where a great deal of seed testing is done, involving the simultaneous testing of many samples of the same species, this apparatus has decided merits, but for miscellaneous work, requiring different temperatures, it is not entirely satisfactory. Its cost is moderate, as the outside pan can be made by any metal smith, while the interior dishes ought not to cost above ten cents each, or may be made of plaster paris by any one.

3. THE VIENNA GERMINATING APPARATUS.

Fig. 38 shows a form of automatic germinating apparatus used at the Austrian Seed Control Station at Vienna. In this apparatus the seeds are placed between double folds of moist filter-paper, which

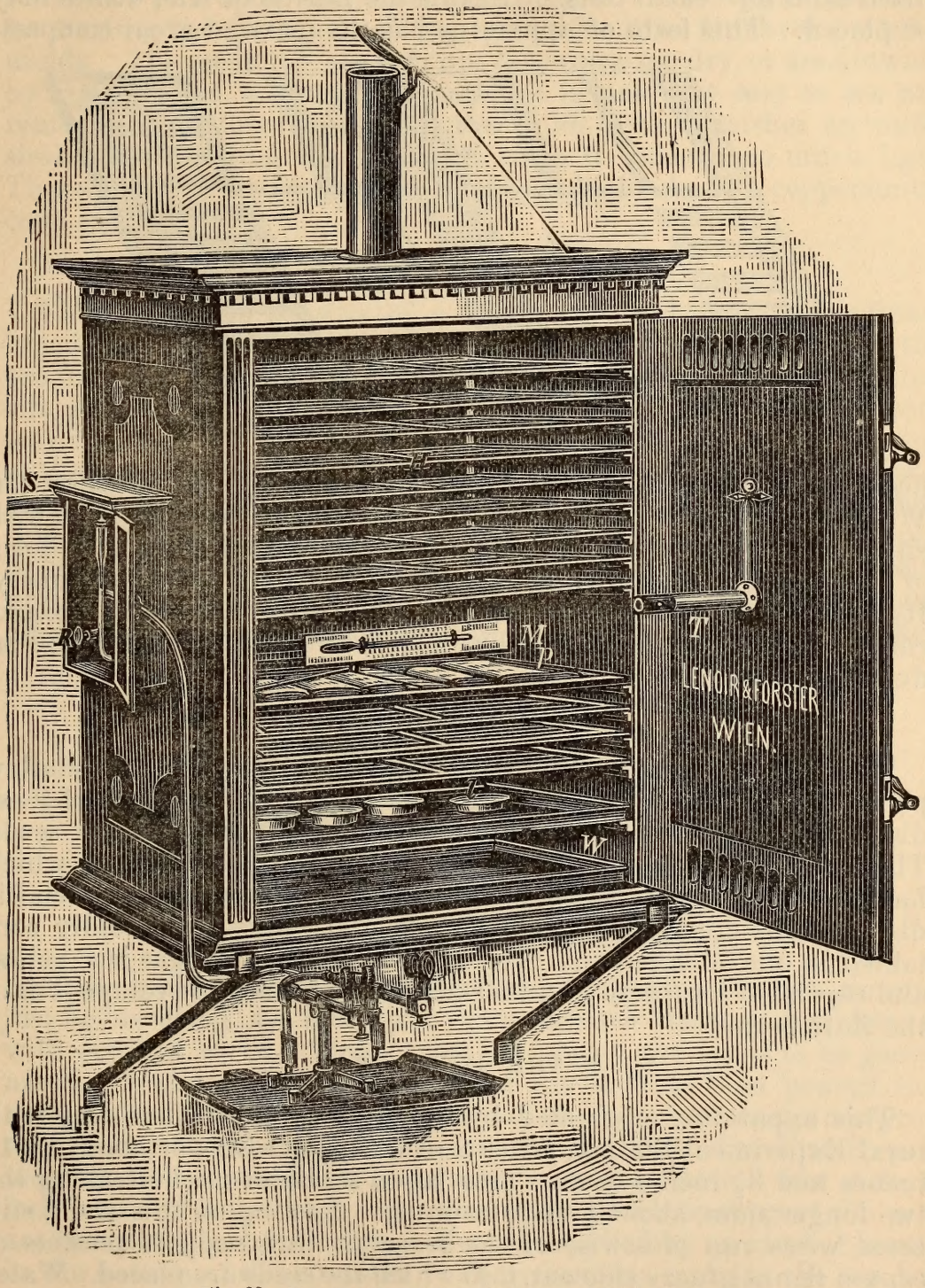


Fig. 38. VIENNA SEED GERMINATING APPARATUS.

opens as does a book. These papers may be laid upon supports of glass strips in a light-tight, zinc-lined chamber, heated from below by gas-jets, whose energy is controlled by means of a thermostat.

The door of the chamber has an automatic ventilator worked by the thermostat. A zinc pan at the bottom of the chamber holds water, evaporation of which furnishes sufficient moisture to keep the filter-paper damp. Another zinc pan above the water-pan contains sterilized sand for "earth tests." In this the Zurich or Kiel dishes may be placed. This form of apparatus has the merit of great compact-

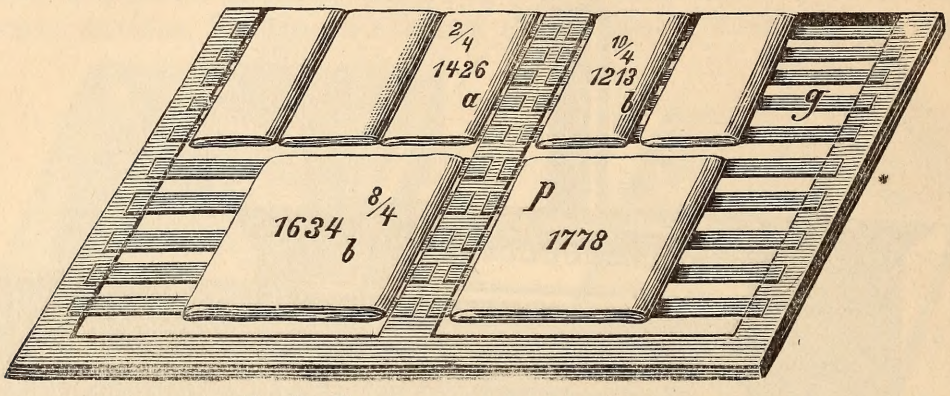


Fig. 39. Tray used in Vienna Apparatus.

ness, simplicity and ease of access and control. Its inventor, Dr. Weinzierl, claims to have obtained better results with this than with either the Nobbe or Zurich apparatus. So far as known, this form of germinating apparatus has not been introduced into this country. Its cost (size 89 x 65 x 38 centimeters) is about $30, without accessories. The accessories cost about $20 additional, all estimated at duty-free rates.

4. THE KIEL PAN.

The essential part of this apparatus is a small square shallow porous dish, about 2½ inches square and ¼ inch deep. Each of these dishes will conveniently hold 200 clover seeds or 100 grass seeds. These dishes are sunken to the rim in a layer of moist sand which has been carefully sterilized, and the whole is contained in a metallic dish of convenient size. From 25 to 100 dishes are usually contained in one outside pan. The heat is supplied by gas-jets below, and regulated by means of a thermostat. This is more compact than the Zurich pan.

5. THE GENEVA PAN.

This apparatus, originated by the Geneva (New York) Agricultural Experiment Station, consists of a copper reservoir about 9 x 14 inches and 3½ inches deep. This has a shoulder or shelf along the two longer sides, about ½ inch from top. Resting on this shelf, stiff brass wires run crosswise of the reservoir and support pockets of canton flannel, fuzzy side out, into which the seeds are placed. Water is then poured into the reservoir, sufficient just to touch the bottom of the pockets, and a cover of metal or glass slides into a groove in the top of the reservoir, thus completely shutting out the air.

The Geneva apparatus has the merit of extreme compactness, as within the space indicated a large number of samples may be tested at one time. The tendency of seeds, like all bodies possessing weight, is to seek the lowest level. In the pockets of this apparatus smaller seeds will pile upon each other, shutting out the oxygen necessary for starting the germ, and giving special facilities for development of molds. The seeds, too, are very apt to become too dry, or are drowned by a surplus of moisture. Finally, it is not very easy to see and remove the sprouted seeds, and the white cloth furnishes an undesirable surrounding for the seeds, since it reflects too much light. This apparatus is not patented, and may be made by a coppersmith; costs about $3.50.

6. THE NORTH CAROLINA PAN.

This apparatus consists of a zinc pan resembling an ordinary bread baking pan, $7\frac{1}{2}$ x $15\frac{1}{2}$ inches, and 2 inches deep. Within this are four zinc trays on legs $1\frac{3}{4}$ inches high. These trays have a raised rim $\frac{1}{4}$ inch high all around and across the middle, dividing each tray into two compartments about $3\frac{1}{2}$ inches square. The bottoms of the trays are perforated with holes, varying for different pans from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter. A ventilated cover goes over the pan, shutting out all light except that entering through small ventilating pinholes, of which there are two dozen, three at each corner and twelve under the handle on middle of pan. The interior of the pan and all the trays are blackened with asphalt paint to absorb light. Squares

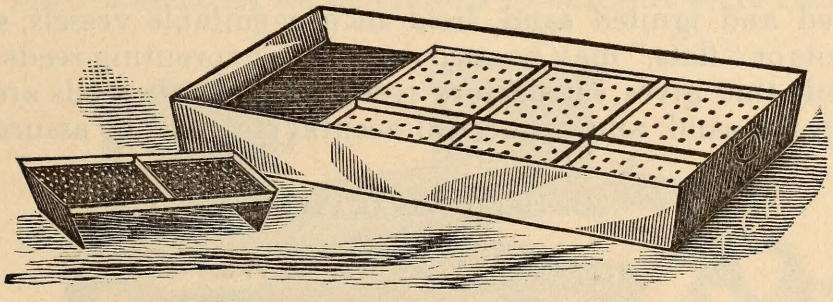


Fig. 40.—North Carolina Seed Germinating Pan.

of thick black woollen cloth, sterilized by boiling for five minutes just before using, are laid upon the perforated trays and moistened with distilled water. Upon these are placed the seeds to be germinated. Water to the depth of about one inch is then poured into the zinc pan, the cover placed on, and the pan laid away in a properly heated chamber. This chamber at the North Carolina Experiment Station consists of a large case, with glass door, 4 feet wide, $1\frac{1}{2}$ feet deep and 9 feet high. Shelves upon which to support the pans are made of $\frac{1}{4}$-inch iron rods. Heat is supplied by an alcohol burner in the bottom of the chamber. Thermometers hung to the top, bottom and center shelves show the temperature. The temperature is regulated by two pair of ventilators at top and bottom of case. After a little preliminary practice with the burner and ventilators the tem-

perature can be regulated to a nicety in our mild and constant climate, but where the temperature of the air and room is liable to sudden and considerable fluctuations, a thermostat would be necessary to insure a constant temperature.

This apparatus, after long use at the North Carolina Experiment Station, has given better average results than either the Nobbe or Geneva apparatus, and better than folded filter-paper laid on moist sand. The cost of the pan is about $2.50. The case, heater, thermostat, etc., are extra.

7. OTHER FORMS OF GERMINATING APPARATUS.

The Botanist of the Royal Agricultural Society of England, for germinating seeds, stands two porous clay bricks on end in a pan of water, and upon these supports a third brick, upon which the seeds are placed. The whole is kept in a dark suitably heated chamber.

A convenient slab of porous baked clay, 12 to 18 inches wide by 2 inches thick, with shallow depressions of about ½ inch depth and 4 to 6 inches diameter on surface, placed in a covered trough holding about one inch of water, has been used by some botanists in sprouting seeds. The chief objection to this is the impossibility of varying temperature and humidity to suit different species of seeds.

Copper, zinc or earthenware pans or plates of any convenient size, containing a layer of sterilized moist sand, upon which are laid pieces of blotting-paper or flannel, between the folds of which the seeds are placed, have been considerably used for seed testing.

Washed and ignited sand, held in any suitable vessels, such as flower-pots or "flats," may be used directly for sprouting seeds. With large seeds this gives satisfactory results, but small seeds are apt to be lost in the sand, and numerical accuracy cannot be assured.

B. Seed Separators.

1. SEPARATION BY SIEVES.

Sieves of different size of mesh are used to separate straw, dirt, etc., from seeds. The separator used at the North Carolina Experiment Station consists of a series of shallow tin cylinders about 4 inches in diameter and 2 inches deep, each piece of which has a perforated bottom of different sized and graduated holes. The pieces slip over the next piece below and under the next above, like links of a stovepipe. Any number of the separable pieces may be used in such a combination. The top piece has a cover, and the bottom a tight base. The size of hole is graduated from the top to the bottom of the combination. The seeds are put in at the top and the cover put on, and the whole agitated for five minutes. This separates the sample into different sized heaps of graded fineness. The bulk of each kind of seed, or of matters of similar size contained in the sample, is found together in one of the compartments. For ordinary small

seed samples, however, it is customary, and takes less time, to spread the sample on a sheet of clean white paper and remove the impurities by hand, using a magnifying glass or simple microscope, when necessary. Some European stations use elaborate separators, such as are illustrated at Fig. 41 and Fig. 42. It is a special agitator for separating dodder from clover seed. Its construction is the same as the hand separator above described, but each dish shown in the cut has but one sieve. The bottom of the upper section is removable, so that sieves of different sized mesh may be used when this apparatus is used as a general separator.

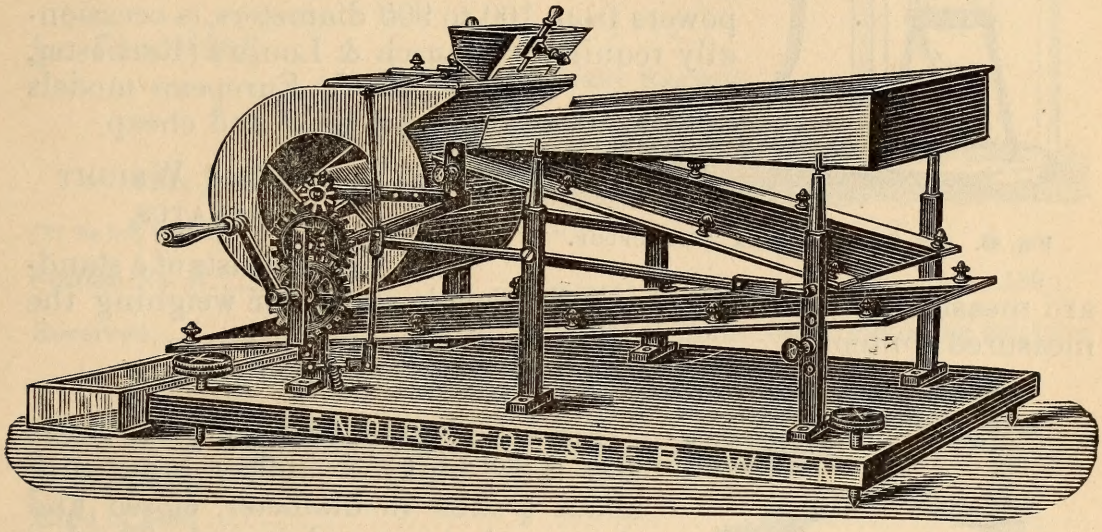


Fig. 41. PRECISION SEPARATOR, FOR DETERMINING THE AMOUNT OF STRAW AND CHAFF IN MEAL AND SEED SAMPLES.

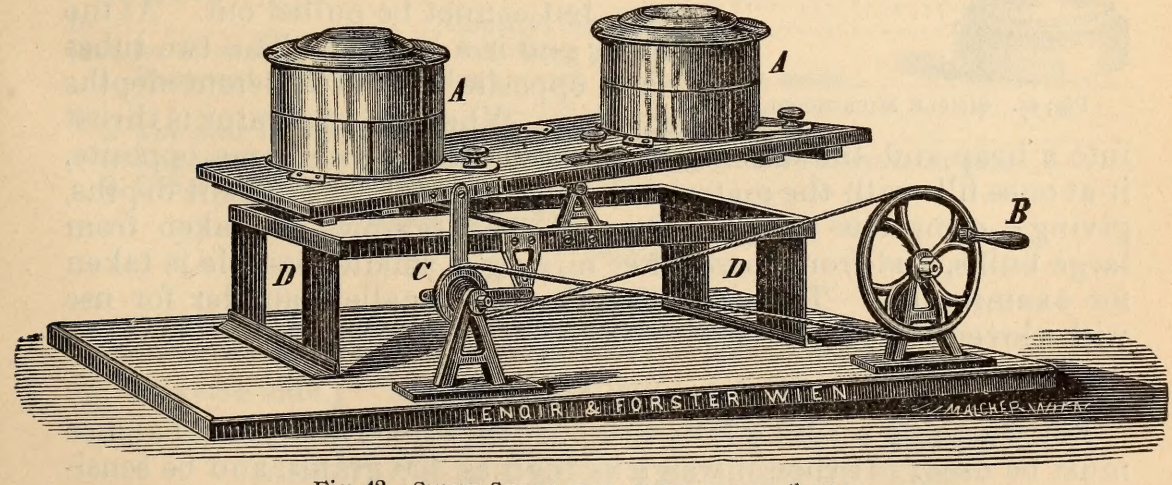


Fig. 42. SIEVE SEPARATOR, WITH THREE SIEVES.

2. THE AIR SEPARATOR, OR SPREUFUGE.

Fig. 43 shows a useful piece of apparatus for removing straw, chaff, etc., from seeds and meal. It is called the "spreufuge." In using the spreufuge, the sample to be cleaned is placed in the inner glass jar, which must not be more than one-half filled; the cover is then put on and the joint covered with a wide rubber band. The bent

glass tube is then placed down to the bottom of the jar and air forced through from the hand-bulb. This brings all chaff, straw, and germless seeds to the surface, where they can be blown out into the larger vessel.

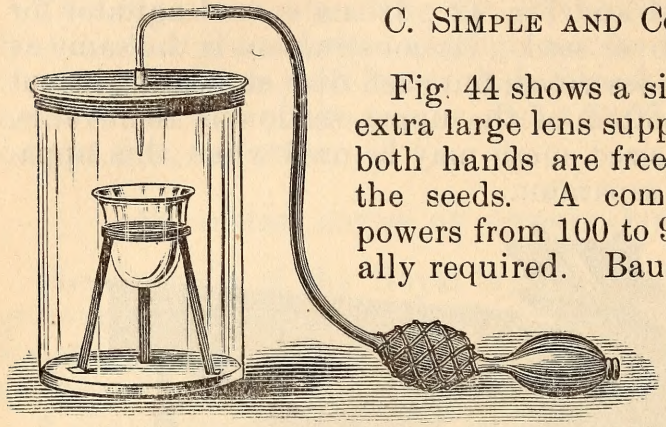


Fig. 43. Air Separator, or "Spreufuge."

C. Simple and Compound Microscopes.

Fig. 44 shows a simple microscope, with an extra large lens supported to the stand, so that both hands are free for use in manipulating the seeds. A compound microscope, with powers from 100 to 900 diameters, is occasionally required. Bausch & Lomb's (Rochester, N. Y.) European models are good and cheap.

D. Volume Weight Apparatus.

This consists of a standard measure (litre) attached to a druggist's scales, for weigning the measured contents.

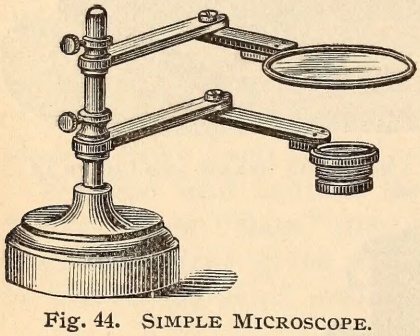


Fig. 44. Simple Microscope.

E. Sampling Apparatus.

For taking samples from grain-sacks and large bulks, a hollow brass tube about $\frac{2}{3}$ inch in diameter, closed and sharpened at one end, is used. This has within it a smaller tube, which turns easy, but cannot be pulled out. At the upper end is a handle. The two tubes have opposite slits at different depths of tubes. When the apparatus is thrust into a heap and the inner tube turned till the slits come opposite, it at once fills with the material through the slits at different depths, giving a composite sample. Several such samples are taken from large bulks, and from these, after mixing, a smaller sample is taken for examination. There is a similar but smaller sampler for use with clover and small seeds.

F. Analytical Balance.

For weighing seeds and their impurities, a good analytical balance must be used. It should weigh as high as 300 grams, and be sensitive to one milligram.

G. Miscellaneous Apparatus.

A sharp-pointed spring forceps for picking up seeds, a thin-bladed knife for counting seeds, a few dissecting needles, a razor, a large reading-glass, some white printing-paper, and filter-paper are necessary. A florist's bulb atomizer for moistening seeds, and an ordinary cylindrical syringe for removing water from the pans are about all the additional apparatus required.

H. Record Books and Blanks.

1. North Carolina station records and blanks.

At the North Carolina Experiment Station the following blank forms are used in seed work:

A. Sampling Blank. [Size, 7 x 8½ inches.]

This is sent to the person desiring to have a test of seeds made.

[*a*. Face side.]

N. C. Experiment Station.

FORM FOR SENDING SEED SAMPLES.

This form must be filled up completely, or sample may be rejected.

(To be left blank.)

Station No. B_____ _____189__

Received_____ Dr. H. B. Battle, Director Experiment Station,

Raleigh, N. C.:

Sir: I send you today, marked _____contained in a_____, a fair sample of seed, drawn according to directions on opposite of this sheet.

Kind of seed _____

Sold by _____

At city or town of_____

Grown by_____

in_____County, State of_____

(Sender of sample must give following particulars:)

1. Supposed name of the plant which produced the seeds _____

_____

2. The year in which the seed were said to be matured _____

3. The price paid for the seed, or for which they were offered for sale_____

4. Other particulars_____

Name of sender _____

Post-office _____

County _____

State _____

[*b*. Reverse side.]

N. C. Experiment Station.

DIRECTIONS FOR TAKING SAMPLES OF SEED.

If the seeds are in small packages, pour out the contents of the package on a sheet of clean paper, mix thoroughly and take a sample of at least one ounce and place it carefully in a clean envelope. If seeds are in bulk or large packages, take a handful each from different depths and parts of the packages, mix these on a sheet of paper, and from this take the sample to be sent to the Station.

N. B.—The Station makes analyses for the citizens of North Carolina without charge, provided—

1. That the results are of some use to the public and the Station is free to publish them.

2. That the samples are taken according to our directions for sampling, and are fully described.

3. And provided further, that the person sending the seeds desires the information to aid him in selecting seed for his own use. The Station cannot, as a rule, undertake to do such work for merchants or those who have seeds to sell.

Samples, when accepted, will be entered upon our register in the order of their coming, and tested in turn.

The results of each examination or analysis will be promptly communicated to the person sending the sample. Results of general interest will be sent simultaneously to the State newspapers or published in the Station Bulletin or Report.

Samples should contain at least 400 seeds and weigh at least one ounce, and should represent a fair average of the whole. Such samples may be sent by mail in pasteboard boxes or common envelopes. The postage is one cent for each two ounces. Postage must be prepaid in all cases.

It will usually be one week in the case of clover seed, and two weeks in the case of grass seed, before a report upon their vitality can be made.

Write your name and address, preceded by the word "from," upon all packages, and put some mark, word or number upon them by which to identify them. THIS IS VERY IMPORTANT. Address all packages to

N. C. AGRICULTURAL EXPERIMENT STATION,
RALEIGH, N. C.

B. Seed Record and Register. [Size of page, 7 x 8½ inches.]

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION.

SEED RECORD.

Received .....

Station No. ..... Reported .....

Sent by ..... From .....

Marks ..... Quantity .....

Scientific name .....

Common name .....

No. of seeds in one gram ..... No. of seeds in one ounce .....

Purity, per cent., ...

Nature and percentage of impurities .....

Viability, per cent., ... Real worth, per cent. .....

(Original.)	GERMINATION TEST.	(Duplicate.)
.....	Experiment begun	.....
.....	Number of seeds used	.....
.....	Date of first germ	.....
.....	Date of last germ	.....
.....	One-half of sample germinated in days	.....
.....	Total germinated seeds	.....
.....	Number of hard seeds remaining	.....
.....	Experiment concluded	.....
.....	Range of thermometer	.....

..... } Remarks. { .....
..... } { .....
..... } { .....

....., Botanist.

NOTE.—The most convenient size of seed record and register is a page 7 x 8 inches, with forms on both sides. It should be strongly bound in book, with water-proof corners and back. The paper should be of good quality and not blister when wet.

C. Seed Report Blank. [Size, 7¾ x 10½ inches.]

Division of Botany and Entomology.
GERALD MCCARTHY, B. Sc.,
Botanist and Entomologist.

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

H. B. BATTLE, Ph. D., Director.

Botanical Analysis
No. B .....

RALEIGH, ..., 18..

SIR: The sample of seed sent to the station for examination in a....., marked....., was received .....

The Botanist of the Station reports the bulk of the sample to be seeds of
.....(Botanical name)
.....(Common name)

The sample contains ..... per cent. of true seed of the plant named, and ..... per cent. of impurities.

The impurities consist of { useful seeds, ...per cent. / noxious seeds, ...per cent. / inert matter, ...per cent.

The sample is calculated to contain ..... seeds to the ounce.

One-half of the seed germinated in ..... days.

There are in every 100 pure seed ..... seed capable of germinating.

There are in 100 parts by weight of the sample ..... parts of pure viable seed. This determination measures the real or cultural value of the seed.

The germinating test indicates that the seeds possess ..... vitality.

Choice merchantable seed of this species should have—purity, ...per cent.; viability, ... per cent.; making the real worth .... per cent., and should be free from .....

Your obedient servant,

.....,
Director.

To.....
.....

NOTE.—Seed samples sent for examination and test should be taken according to our directions, and must be fully described. At least 400 seeds, or one ounce by weight, should be sent. Of the larger and heavier sort, two ounces.

2. ZURICH STATION BLANKS.

Dr. F. G. Stebler, Director of the Zurich Seed Control Station, has kindly furnished copies of blanks used in that Station, of which copies translated into English are here subjoined.

A. Seed Mailing Envelope. [Size, open, 4 x 8½ inches.]

SIZE OF SAMPLES. Grasses, . . . 40 grams. Clovers, . . . 100 grams. Sanfoin, Lupine, Cereals, etc., . . . 250 grams.	SAMPLE .... OF NO VALUE. THE FEDERAL CONTROL OFFICE FOR SEEDS, ZURICH. Sender's name: OBERSTRASSE, ... Switzerland.

The above described envelope is made of tough manilla paper, and has a round-headed brass fastener attached at open end. These envelopes are supplied by the Station to its patrons.

B. Preliminary Report Blank. [Size, 5½ x 8½ inches.]

PRELIMINARY OPINION AND PURITY.

No.----- Entry date----- } 18--
Opinion date----- }

Label:----------

Right name: ----------

Guarantee:-----per cent. purity, ------ per cent capability of germination.

Quality, price, etc.: ----------

Seal:---------- Witnesses: ----------

The sample contains:

---------per cent. pure seeds (Purity)

---------per cent. foreign seeds, as:----------

---------per cent. earth, sand, small stones, chaff, broken bits, tares.

100.0 per cent.

The sample weighing----------Grams contains----------reckoned per Kilo---------seeds----------

GENERAL REMARKS.

Purity: ----------

Quality of pure seeds: ----------

Supposed capability in germination: ----------

Summary remarks:----------

Opinion of the Control office for the examination of seeds, Zurich (Switzerland).

C. Complete Report Blank (Face). [Size, 11½ x 9 inches.]

CONTROL OFFICE FOR THE EXAMINATION OF SEEDS.

ZURICH, FEDERAL LABORATORY, DATE 18

To .....

in .....

RESULT OF EXAMINATION.

Control-number	Designation of seeds	The sample contains: Foreign substances i. e. Foreign seeds pr. ct.	Earth, sand, chaff, debris, etc. pr. ct.	Pure seeds (Purity) P pr. ct.	Of the pure seeds germinated: In how many days?	Per cent.	Of the seeds remaining "hard" have been accepted as capable of germination pr. ct.	Therefore capability in germination (7+8) G pr. ct.	The goods contain therefore pure seeds capable of germination (real value) $\frac{P \times G}{100}$ pr. ct.	Remarks
1	2	3	4	5	6	7	8	9	10	11

AVERAGE RESULTS OF FORMER EXAMINATIONS.

Designation of seeds	Purity pr. ct.	Capability of germination pr. ct.	Real value pr. ct.	Designation of seeds	Purity pr. ct.	Capability of germination pr. ct.	Real value pr. ct.

The Director of the Control office of seeds:

DR. F. G. STEBLER.

C. *Complete Report Blank* (Reverse side).

REMARKS AND EXPLANATIONS.

1. REAL VALUE. By Real value (column 10) is meant the per cent. of seeds, pure and capable of germination, contained in the goods; it is reckoned by multiplying purity (P) by capability (G) in germination and dividing the product by 100. For example, does purity amount to 90 per cent. and capability in germination of the pure seeds to 80 per cent., the Real value comes to 72 per cent. Such goods are then marked as 72 per cent.—so that 1 pound of 72 per cent. goods has as much Real value as 2 pounds of 36 per cent., or 4 pounds of 18 per cent., or 8 pounds of 9 per cent. goods.

2. PRICE. If the price of 1 pound of 72 per cent. goods comes to 25c., one pound of seeds pure and capable in germination (= 100 per cent.), 25c. × 100: 72, comes to 34.7c. When both the per cent. Real value and price are known, the value of goods is easily found. Those goods are the most profitable in which the pound of pure seeds and capable in germination comes cheapest. You can often discover by a simple reckoning that the goods which are cheapest in gross weight are really the dearest, and *vice versa.*

3. CAPABILITY IN GERMINATION. The given per cent. capability in germination is the average of a trial with at least 2 × 200 seeds. For the experiment in germination it requires 6 days for Hemp, Corn, Vetches; 10 days for Red Clover, Lucerne, Crimson Clover; 12 days for Sanfoin, White Clover, Hybrid Clover, Perennial Rye Grass, Italian Rye Grass, Tall Oat Grass, Meadow Fescue, Timothy, Flax; 20 days for the finer grass seeds, and Beet; 30 days for Fir, Pine, Larch. In the valuation of seeds for capability in germination, of Red Clover, Lucerne, Sanfoin, Crimson Clover, one-half of the hard seeds is used, of the rest a third part. (See column 8.)

4. CHOICE OF A SAMPLE has to be made in such a way that the sample chosen answers to the average quality of the goods. If the seeds are in sacks, samples must be taken from each sack and mixed (from the top, the middle and the bottom of the sack). From this large sample must be taken the average sample to be sent.

5. THE SAMPLES OF PURCHASERS must be taken out of UNOPENED sacks, before witnesses, and be sealed with the seal of a witness. The witnesses are responsible for a right choice of a sample, and have to certify this on a certificate. In important cases two samples of the same goods must be chosen, sealed and sent, of which one is kept for extra examination.

6. THE WEIGHT OF SAMPLES must be at least:

40 grams of grasses (of Timothy 100 grams).
100 grams of clover and such like seeds.
250 grams of the larger seeds, as Sanfoin, Cereals, Vetches, etc.

The result is generally inexact when the samples are small, and the Office refuses every responsibility.

7. GUARANTEE. Whenever possible, it is better to buy the seeds from those seed merchants who are under the Station Control, and to get a guarantee for a certain per cent. of purity and capability in germination. With clover seeds the guarantee must also comprise the freedom from dodder, and with sanfoin the freedom from pimpernel.

8. CONTROL. Each purchaser ought to assure himself at the Control Office, by an after-examination, whether the goods answer to the guarantee or not, for it is often the case that the goods themselves do not agree with the guarantee in the least. The seeds sent in generally undergo a preliminary examination within twenty-four hours after their arrival, the result of which can, if desired, be sent by telegraph. During the experiment in germination the sender is kept informed from time to time, by means of a postal card, of the progress. At the end of the experiment in germination (see above "Capability in germination") the complete report is given.

9. COMPENSATION. When the Control gives a result in which the Real value is more than 5 per cent below the guarantee, each Control firm is bound by contract to make good the loss or to take back the goods, should the purchaser desire it. Suppose 96 per cent. Purity and 80 per cent. Capability in germination, = 76.8 per cent. Real value are guaranteed, but the Control report gave only 90 per cent. Purity and 60 per cent. Capability in germination, = 54 per cent. Real value. 17.8

per cent. are to be made good, the remaining 5 per cent. being allowed as margin for the possible error of analysis. If the price of the seeds as guaranteed amounts to 7 cents per pound, 1 per cent. of pure seed capable of germinating would cost 7: 76.8 = .09 cents. As there are 17.8 per cent. to be made good, the compensation per pound amounts to 17.8 × .09 cents. For 100 pounds this is $1.60.

Such a method for calculating the indemnity was agreed upon by the Association of German Seed Testing Stations at Hamburg, December 19, 1876. The agreement reads as follows: "Indemnity = purchase price multiplied by the decreased value found, less 5 per cent., divided by the per cent. of Real value guaranteed. Seeds of which the Real value found by analysis falls 5 per cent. or less below the guarantee are to be considered as good as the guarantee."

D. Private Contract Blank. [Size of page, 8½ x 11 inches.]

PRIVATE CONTRACT.

(Not Control Contract.)

Between .....

and the Swiss Control Office for the examination of Seeds, in Zurich, the following contract has to-day been agreed upon:

The firm .....

has the right to have, every year, commencing from the 1st of July, 18....., till ....., 18....., ... samples fully examined (No. 7, §15 of the Regulations) by the Swiss Control Office for the examination of Seeds, and pays for this to the said Control Office a yearly amount of francs, ..., in words, ... francs.

Should the yearly examinations asked for by said firm exceed ..... in number, then every additional full examination must be paid at the rate of ..... francs.

Part examinations, Nos. 1–6, are charged only in proportion, viz.:

No. 1.	Examination as to genuineness	$\frac{2}{10}$	} of a full examination.
" 2.	" " " Pimpernel	$\frac{1}{10}$	
" 3.	" " " the containing of Dodder.	$\frac{4}{10}$	
" 4.	" " " purity	$\frac{6}{10}$	
" 5.	" " " the power of germination,	$\frac{4}{10}$	
" 6.	" " " quality	$\frac{4}{10}$	

The examinations provided for in § No. 8–16 are reckoned, independent of this agreement, according to the tariff.

The yearly amount for this private contract of ..... francs has to be paid in advance every 1st of July, and the final account must be settled at the end of every fiscal year, viz., on the 30th of June.

This contract is made out in duplicate, and signed by both parties, with right to cancel it at six months notice given by either side.

This private contract does not give to the firm the right to consider itself as a Control firm. (§16 of the Regulations.)

Zurich, ...

For the Swiss Control Office for the examination of Seeds:

.....

Director.

.....

The seed trade firm:

.....

E. Certificate of Guarantee, and Sampling Blank, given by a Control seed house to every purchaser of seeds. [Size of page, 7½ x 9 inches.]

CERTIFICATE OF GUARANTEE, CONVEYING THE RIGHT OF GRATUITOUS ANALYSIS.

To the Federal Station for Testing Seeds, Zurich, Switzerland:

The undersigned controlled seed house has this day sold to Mr. ....., of ....., the following seeds, with the annexed guarantee of quality. The purchaser is entitled, under our contract, to have a sample tested free of charge:

Marks and number of sacks from which sample is made up.	Name, variety and place of growth of seeds.	Price per kilogram.	Guarantee.		
			Purity, pr. ct.	Viability, pr. ct.	Freedom from certain substances.

Place.....

Date ..... Control House of.....

CERTIFICATE OF WITNESSES:

[One witness must attach seal with wax.]

.....witness

Place..... [L. S.] .....witness

Date ..... Signature of purchaser.....

APPENDIX.

CIRCULAR. (*See page 356.*)

[SECOND EDITION.]

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,

RALEIGH, N. C., May 30th, 1889.

DEAR SIR: The North Carolina Experiment Station has been for some time past engaged in testing the purity and vitality of flower, field and garden seeds sold in the market. The Station has found its work much incommoded and the value of the results greatly depreciated by having no trustworthy standard with which to compare the seeds tested.

Most seedsmen now print upon their seed packets a wholesale disclaimer of responsibility for the worth of the seeds contained therein. So long as the field test—subject, as it always must be, to accidents of the weather and the prevailing ignorance of plant physiology upon the part of the planter—was the only test applicable, such a disclaimer might be permissible. But since the establishment in most of the States of Experiment Stations, with competent botanical specialists and improved sprouting apparatus, by means of which any desired temperature and humidity can be maintained, there seems to be no good reason why the quality of merchantable seeds should not be made to approximate to some recognized standard, as is the case with most other articles of merchandise.

The establishment of a generally accepted standard of seed vitality and purity would greatly benefit the Experiment Stations by enabling them to attain greater exactness in their seed analyses, and in reducing to a uniform basis the work of the several Stations. It would also benefit honorable seed growers, who have at present to contend against the unfair competition of unscrupulous persons who take advantage of the lack of any efficient control to victimize the public for their own private benefit.

This Station has tested many samples of store seeds which contained less than 10 per cent. of viable seeds, and others which contained as high as 40 per cent. of impurities, including seeds of many noxious weeds very difficult to eradicate when once given a foothold.

The North Carolina Experiment Station is desirous of collecting data for the establishment of a LABORATORY STANDARD of value for all the more common flower, field and garden seeds. In seeking to establish such a standard, we are not working for the benefit of the citizens of our own State only. It is the policy of the American Agricultural Experiment Stations for each Station to give special attention to some particular line of work of general utility, and publish the results for the benefit of the public at large.

Our standard will be submitted to a meeting of the officers of the Experiment Stations, and, with such modifications as may be thought necessary, will probably be adopted tentatively as a National Standard. This, then, is a matter that concerns you personally as a business man. It is to your interest that the standard adopted shall be one just and satisfactory alike to the seed grower and the seed user. We are anxious that it should be so, and to this end have sought to enlist the good will and active co-operation of the seed growers of the United States.

When all the answers to this circular have been received, they will be collated and a tentative standard adopted according to the tenor of the replies. The result will be published in a Bulletin to be issued from this Station, a copy of which will be mailed to each person replying to the circular.

Respectfully yours,

GERALD McCARTHY, Botanist.

Approved:

H. B. BATTLE, Director.

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Feeding Trials with Animals

INCLUDING

I. THE EFFECT OF COTTON-SEED HULLS AND MEAL AS CATTLE FOOD.
II. COTTON-SEED MEAL AS A HORSE FOOD.
III. COTTON-SEED MEAL FOR PIGS.
IV. COTTON-SEED MEAL FOR CALVES.
V. FEEDING SKIMMED MILK TO LAMBS.
VI. A PIG-FEEDING TEST.
VII. A SYSTEM OF FEEDING YOUNG CALVES.

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RALEIGH, N. C.

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FEEDING TRIALS WITH ANIMALS,

INCLUDING

I. THE EFFECT OF COTTON-SEED HULLS AND MEAL AS CATTLE FOOD.
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VII. A SYSTEM OF FEEDING YOUNG CALVES.

BY F. E. EMERY AGRICULTURIST.

I. THE EFFECT OF COTTON-SEED HULLS AND MEAL AS CATTLE FOOD.

Cotton-seed hulls form about half the weight of cotton seed. They are hard and dry, and are usually covered on the outside with a short fuzzy lint. Hulls from poorly cleaned or green seed may be quite rich in food from broken kernels left in the hulls. Reference is here made to commercial hulls only as they have been purchased for experimental use at various times. There are several points in their favor, however, especially convenience of handling and cheapness. They form a handy medium to dilute condensed food, and give that extension to the animal stomach, especially to ruminating animals (cud-chewing), which is regarded so essential to good healthy digestion.

Cotton-seed meal is the ground residue, or cake, that is left after expression of the ground and steamed kernels from which the hulls have been separated. It is a bright yellow meal with a sweet nutty flavor which is pleasant to the palate. Some samples contain brown or black specks from hulls ground into the meal. This is either an accidental impurity or an intentional adulteration. Cotton-seed meal deteriorates with age and becomes discolored. It is probable that feeding this aged meal, in which chemical changes have taken place, is the cause of the prejudice against its free use. Fresh cotton-seed meal has been fed with the utmost freedom to some experimental

stock, with good effect, and no visible harm has resulted. The meal is poor in carbohydrates, starch, sugar, etc., but rich in fat, and is, perhaps, the richest nitrogenous by-product known which can be utilized as cattle food. It is so rich in this costly part of cattle food that it needs to be mingled with some coarse article which can supply carbohydrates to balance the protein or albuminous part of the meal, so that the animal may use the foods economically. Too much protein is too expensive, and too little is wasteful of the carbonaceous food material used. There must be a certain definite ratio existing between these different classes of foods available to the uses of the animal organism in order to perform its functions to the best advantage. To meet the requirements of our domestic animals in this respect, the German standards have been devised. They do not apply exactly to American needs, and are especially at fault with these by-products under discussion.

The foods best suited to balance cotton-seed meal are corn silage, straw of the cereal grains, corn stover (the stalks after the ears are harvested), poor hay, shucks, etc., all rough cattle foods, and cotton-seed hulls. Stock can be induced to eat these foods for the sake of the meal which can be mixed with them. The cotton-seed hulls can thus be reunited with the meal, with great advantage to the cattle-feeder, after the oil has been extracted. The hulls are the handiest of all to mix and feed, and, when supplied at a price lower than straw, are a good substitute for it as a bulky base to supply carbohydrates in order to balance the protein of the cotton-seed meal.

Feeding cotton-seed hulls and meal together has come to be a regular practice for fattening beeves in the vicinity of oil-mills, and is in process of extension to other localities. Stock fatten very readily on the combination of hulls and meal mixed in proper proportions. What these proper proportions should be have scarcely more than been guessed at in ordinary practice. The German standards, and the usual calculations based upon them, do not give reliable ratios with these foods, and only a few practical feeders, up to this time, have come very near the truth. This Station has been engaged upon the investigation of this matter, together with other questions relating to cattle foods and animal nutrition. Definite proportions between hulls and meal have been digested by animals under experiments with successive trials of rations richer in cotton-seed meal, until a point has been reached beyond which, except, perhaps, in some special cases, it is believed that meal cannot be much greatly increased without incurring financial loss.

We have conducted careful digestion tests, and have determined the amounts actually digested in various combinations. Beginning first with hulls fed alone, then adding meal carefully, the proportions were increased in the successive rations fed. Comparing the results with calculated rations, the data obtained have brought this subject to such a degree of accuracy that feeders may expect reasonable success in feeding stock on cotton-seed hulls and meal, according to the object sought.

The chief rations subjected to digestion are here briefly reviewed, and some of the more practical points noted. Every statement below made is substantiated by feeding trials, reports of which have been or will be made. References are to Technical Bulletins 3 and 4, and to Bulletins 81, 90, 93, and 97.

Result of Feeding Cotton-seed Hulls and Meal.

1. Cotton-seed Hulls Fed Alone.—These have been fed alone to four animals and the amounts digested carefully determined. At the Texas Station also, hulls were digested by six steers (Bulletin 15). As a summary of the whole matter it may be stated the hulls do not furnish food sufficient to support life. Reference here is only to ordinarily well cleaned hulls.

*2. Cotton-seed Hulls and Meal—First Ration** (No. 2 of Table).—Hulls and meal were fed and eaten in the proportion of 7 of hulls to 1 of meal. This maintained the weight of the nearly dry cow, which was producing about 20 ounces of milk daily. This cow weighed approximately 950 pounds. This may be termed a maintenance ration. The nutritive ratio was 1:10.8. This ration gave about 1 pound of digestible protein, 1.22 pounds digestible fat, and 7.59 pounds digestible carbohydrates.

3. Cotton-seed Hulls and Meal—Second Ration (No. 3 of Table).—Hulls and meal were fed in proportion of 6 to 1. They were eaten in the proportion of $5\frac{1}{2}$ to 1 by two steers. The nutritive ratio was 1 to 9.7. Six other steers were fed on this ration and all ate at the rate of $5\frac{1}{4}$ to 1 for 20 days. For this period the gain was 1 pound per day for each 1,000 pounds live weight of the eight steers.

4. Cotton-seed Hulls and Meal—Third Ration (No. 4 of Table).—Cotton-seed hulls and meal were fed, in the proportion of 4 to 1, to the same lot of steers as were used for the second ration. The nutritive ratio digested by two of the steers was 1:7.5. The proportion eaten of hulls to meal was $3\frac{2}{3}$ to 1. These two steers were prepared for market before this period began, and one maintained his weight, whilst the other lost The other six steers gained at the rate of 1.09 pounds per day and per 1,000 pounds live weight. The eight steers consumed $18\frac{1}{2}$ pounds of cotton-seed hulls and $4\frac{7}{8}$ pounds of cotton-seed meal per day and per 1,000 pounds live weight.

5 Cotton-seed Hulls and Meal—Fourth Ration (No. 5 of Table).—Hulls and meal were fed in ratio of 3 to 1 for 18 days from time of receiving the steer. There was a loss of weight for six days, caused by change of location. The feed overcame the loss, and the steer gained weight for 12 days, but only exceeded original weight, at the end, as much as the weight of the water drank toward the end of the feeding exceeded the weight drank during the early part of the period. This ration was not fed long enough to establish a rate of

*Technical Bulletin No. 3, N. C. Experiment Station.

gain, after making up for the loss due to change of location. Nutritive ratio 1:5.96. Another steer being fed 41 days on this ration, left a little waste hulls at wide intervals, and gained 1.16 pounds per day and per 1,000 pounds live weight.

6. Cotton-seed Hulls and Meal—Fifth Ration.—Rate of feeding 2.8 to 1. Consumed as 3 to 1. Nutritive ratio 1 to 5.13.

7. Cotton-seed Hulls and Meal—Sixth Ration (No. 6 of Table).—Fed cotton-seed hulls and meal in the proportion of 2 to 1. Feeding as in former trials was close to the limit of appetite. No waste. Nutritive ratio 1:4.27. Fed to one steer 13 days produced a gain of 5 pounds per day, or 4.4 pounds per 1,000 pounds live weight. Fed to another steer 56 days, produced an average gain of 2.43 pounds per day, and per 1,000 pounds live weight, allowance being made for excess of water in previous period. This steer ate 18 pounds of hulls and 6 pounds of meal, except on the 38th day, when $4\frac{1}{4}$ pounds of waste was left. This was 16 pounds hulls and $5\frac{1}{3}$ pounds meal per day, and per 1,000 pounds live weight, waste being neglected. After feeding for 56 days the hulls were increased to $22\frac{1}{2}$ pounds and the meal reduced to $7\frac{1}{2}$ pounds. This was fed for five days. Then both were increased to 27 and 9 pounds per day for 17 days. The meal was all consumed except a small amount mixed in the hulls one day. There were 24.36 pounds of hulls consumed. So the proportion eaten was 2.8 to 1. The steer gained for this time 2.66 pounds per day and per 1,000 pounds live weight.

8. Corn Silage Alone (No. 7 of Table).—This was fed alone to a heifer, about $2\frac{1}{2}$ years old, and not a very hearty eater.

9. Corn Silage and Raw Cotton Seed (No. 8 of Table).—Corn silage and raw cotton seed were fed to same heifer and following the corn silage alone.

10. Corn Silage and Roasted Cotton Seed (No. 9 of Table).—Corn silage and roasted cotton seed were fed to the heifer "Spot" and "Steer No. 3" of about same age as above.

11. Corn Silage and Cotton-seed Meal (No. 10 of Table).—Corn silage and cotton-seed meal were fed to two steers about three years old. One steer, the smaller, gained most. For 14 days the gain was 4 pounds per day, calculated to 1,000 pounds live weight. See Bulletin 93, Article II, p. 41, for statement of whole period and rations for the whole time.

NOTE.—In feeding these rations in definite proportions, the amount to feed any given animal can be found by testing the appetite of that animal. While the proportions are kept the same, these rations are good for any amount that can be eaten regularly.

TABLE I.—Rations and Amounts of Digestible Nutrients Fed to Stock, and the Result.

Number of Ration.		Total dry matter. Per 1,000 pounds weight.	Pounds of Digestible Nutrients Consumed per Day and per 1,000 lbs. Live Weight.					Result.
			Protein.	Carbo-hydrates.	Fat.	Nutritive Substance.	Ratio 1 to	
1	Cotton-seed hulls fed alone	10.30	.034	3.495	.4378	3.967	135.	Weight lost.
2	Cotton-seed hulls and meal fed in proportion of 7 to 1	22.80	1.001	7.688	1.241	9.930	10.8	Wt. maintained and yield 18.6 of milk.
3	Cotton-seed hulls and meal fed in proportion of 6 to 1	21.19	1.067	7.62	1.006	9.70	9.5	Gain 1 lb. per day, and per 1,000 lbs. wt.
4	Cotton-seed hulls and meal fed in proportion of 4 to 1	20.55	1.47	8.192	1.092	10.765	7.5	Gain. (See Bulletin 93, p. 18, 6th period.)
5	Cotton-seed hulls and meal fed in proportion of 3 to 1	21.466	1.875	8.645	.992	11.512	5.9	
6	Cotton-seed hulls and meal fed in proportion of 2 to 1	24.234	2.805	8.944	1.264	13.013	3.9	
7	Corn silage alone	10.27	.264	4.918	.173	5.355	20.	Wt. maintained
8	Corn silage and raw cotton seed, 2⅔ to 1	12.50	.942	4.945	1.455	7.342	9.16	Wt. maintained
9	Corn silage and roasted cotton seed, 3.5 to 1, nearly	13.36	.723	5.23	1.31	7.26	11.77	
10	Corn silage and cotton-seed meal, 8 to 1	22.98	2.866	11.98	.923	15.764	4.98	Gain 4.00 lbs. daily per 1,000 lbs. wt.

Rations of Hulls and Meal Recommended for Specific Objects.

1. For Maintenance.—Where it is desirable to feed an animal just sufficient to maintain it without loss, the following rations may be used:

Hulls from rather green seed may be fed alone, the particles of seed kernels remaining accidentally with the hulls being counted on for maintenance, or, perhaps, even for slow fattening. Dependence, of course, is placed on the amount of kernels left in the hulls. With well cleaned hulls, however, some cotton-seed meal must be used, depending somewhat on the animals fed. With the cow weighing 950 pounds, one pound of meal to every seven pounds of hulls has been shown to maintain the weight and produce about 20 ounces of milk per day. Probably 8 or 10 pounds of hulls to 1 pound of meal,

when fed in quantity (as much as can be eaten clean), will support life and maintain the weight of neat stock.

2. For Slow Fattening.—Rations ranging from 7 of hulls to 1 of meal down to 5 or 4 to 1 may be used, depending on the animals fed and skill of the feeder. Each animal should be provided with just what it can consume and no more. With thrifty stock 4 to 1 will produce very good growth, or in mature animals it may be counted on to fatten in from 80 to 100 days.

3. For Quick Fattening.—Rations for making good beef quickly may range from 4 to 1 down to 2 to 1, or even 1.5 to 1, as we have fed steers successfully on the latter ration. For feeding half-fat cattle from 30 to 45 or 60 days, these last rates are well calculated to increase the body weight. But it is doubtless a good plan to heed the German standard and feed the wider ratio at the last, in order that more of the digestible food may be fixed as muscular tissue.

4. For Milk.—For the deepest flow of milk, we consider it a doubtful practice to feed exclusively on hulls and meal, though both may be prominent articles in the ration. We prefer to fill up a cow on more digestible food than hulls. If cotton-seed meal is fed in quantity sufficient to support a cow giving a large flow of milk, it may occasion danger to her health, as it certainly does where fed to pigs and calves in like manner. When a cow has passed about four or five months of gestation, and the flow of milk has greatly diminished, she may be put on a ration of hulls and meal, which may be varied from 4 to 1 to as much as 7 or 8 to 1 of hulls to meal until she has dried off. This will support the cow well. It would be well all this time, however, to be feeding once per day some hay, stover, straw, or let her graze part of each day. For two or three weeks before calving, the cow's ration should be changed by substituting a succulent diet or bran for the cotton-seed meal. A week before calving, if not already affected by the succulent diet, the cow should be thoroughly purged with Glauber's or Epsom salts, in one pound dose. Care should be exercised to see that the bowels remain loose, if not, repeat the dose at intervals, as needed, until the cow has come to her full yield of milk after calving. By a little care, a feeder will thus save losses of stock and veterinarian's fees.

5. For Other Stock.—To other than ruminating animals, the use of either cotton-seed hulls or meal is yet of doubtful expedience. Hulls are too bulky for horses, yet cotton-seed meal may often be fed, in *small* quantities, to good advantage with the usual wide ratio rations. Its action, however, on the nervous system is yet untried, so far as we are informed, and it would only be safe as a small part of a ration to be used, much as linseed meal or flax seed is sometimes used. This meal, in small quantities, is not so laxative as linseed meal.

II. COTTON-SEED MEAL AS A HORSE FOOD.

Cotton-seed meal is so rich in protein that it is one of the best foods with which to "balance" rations. It has become a standard food for cattle and sheep. Why not use it for horses and mules? Thousands of work animals in North Carolina can be better and more cheaply fed if cotton-seed meal is used for part or all the grain. No experiments that we know of had been made when we began to agitate the question, though some cotton-seed meal feeding to such stock may have been done.

Two old horses were secured for the purpose of ascertaining the effect of cotton-seed meal in a ration. They were fed a good ration for ten days, consisting of clover chaff threshed out with crimson clover seed, corn meal and ship-stuff. One horse gained and one lost weight on this ration, while both were kept at usual work. No. 1 gained 1.7 pounds daily, and No. 2 lost .97 pound daily. The ration fed during this period to both horses is given as No. 1 below.

During the second period both horses gained weight—No. 1 at the rate of 1.6 pounds per day, and No. 2, 4.1 pounds; or, if the apparent loss in weight of No. 2 during the first period were due to reduced stomach contents, consequent on change to better than previous ration, and this gain distributed over the two periods, it would be equivalent to 1.56 pounds per day. The daily weights show irregularity and falling back during the first period; but when two pounds of cotton-seed meal had replaced two pounds of corn meal and ship-stuff of the ration in the first period, there was an almost regular advance in body weight.

After the first two periods the same chaff was continued two days and the grain changed by reducing corn and ship-stuff one pound each and increasing the cotton-seed meal one-half pound. Then, with the grain fed regularly as thus changed, timothy hay was fed in place of the chaff. Horse No. 1 refused the hay, and ate only what meal he could pick off, leaving hay, saliva and meal in excess of the hay fed. He was discarded after four days of this kind of feeding. Horse No. 2 was continued eight days, but did not eat the hay well, although he nearly held his weight. Neither horse showed any symptoms to indicate that the cotton-seed meal disagreed with them, but both objected to late-cut timothy hay after crimson clover straw and chaff.

The rations fed and consumed were as follows for both horses during two periods of ten days each, and also what was fed during the third period:

TABLE II.—Rations containing Cotton-seed Meal fed to Horses, and Consumed during various Periods.

	FIRST PERIOD.		SECOND PERIOD.		THIRD PERIOD.
	Pounds Fed.	Pounds Eaten.	Pounds Fed.	Pounds Eaten.	Pounds Fed.
Smith's Horse.					
Clover Straw (chaff)	18.	17.8	17.	16.44	9
Ship-stuff	5.	5.	4.	4.	2
Corn Meal	5.	5.	4.	4.	2
Cotton-seed Meal	----------	----------	2.	2.	2½
Horse No. 2.					
Clover Straw (chaff)	18.	16.46	17.	17.0	9
Ship-stuff	5.	5.	4.	4.0	2
Corn Meal	5.	5.	4.	4.0	2
Cotton-seed Meal	----------	----------	2.	2.0	2½

The timothy hay would have been fed *ad libitum* if horses had eaten it, and the grain also raised to make a fairly balanced ration with it. The only object in view, however, was to study the effect of feeding the cotton-seed meal.

This refusal of timothy hay is only an additional indication of the false value placed on this hay. It is far from being worth as much as many other kinds of grass or of mixed grasses. Previous to this feeding trial, we have received one report of one pound cotton-seed meal daily, having been fed to mules with other grain.*

Later in reply to an inquiry, Mr. E. d'Alinge, of the Biltmore estate, writes that he has for some time been feeding two pounds per day, except Sundays, to work-horses and mules. The ration, with cotton-seed meal in this case, being as follows: 13 to 15 pounds cut hay and finely cut corn fodder; 4 pounds wheat bran; 2 pounds cotton-seed meal; 6 pounds corn meal. The whole mixed together. On Sundays a change is allowed to whole grain, oats and corn, and uncut hay

This experience should be worth a great deal to owners of work stock. There is no food so rich in albuminoids that can be obtained so cheap as cotton-seed meal, and nothing else will go so far for a given weight in balancing rations of coarse foods as hay, stover, pulled fodder, straw, etc. No one need work a poorly fed horse, mule or steer if he will only heed this experience and profit by the directions already given in a previous bulletin (No. 106).

III. COTTON-SEED MEAL FOR PIGS.

[See Page 433 and following for detailed description. Supplied upon application to the Director.]

While two native pigs were being fed on skim-milk, one was put on a ration of cotton-seed meal and wheat bran; the other on corn meal and bran. After about six weeks feeding on small quantities

*Bulletin 106, p. 317.

of these meals, they were increased to two pounds per day, and the cotton-seed meal apparently caused the pig to which it was fed to pine until food was refused. After a change to corn meal was made, the pig recovered. The pig which was fed on the corn meal throve all the time. Later a little more cotton-seed meal was fed, but, rather than risk the loss of the pig, it was dropped. After feeding a period on corn meal, both were slaughtered and comparisons of live and dressed weights were made. The pig which was fed on cotton-seed meal weighed twenty-five pounds less than the other, and dressed 71.21 per cent. of live weight. The pig fed on corn meal dressed 73.68 per cent. of live weight.

It is shown that these native pigs were fed at a loss of the bran and meal fed, excepting the manurial value, counting the skim-milk as worth two cents per gallon. If the grain was charged for, the skim-milk brought less than half a cent per gallon.

A summary of a feeding test of pigs on cotton seed and cotton-seed meal, made by the Texas Experiment Station, published since the above feeding was concluded, shows that of three pigs fed raw cotton seed, two died; of eight pigs fed roasted cotton seed, six died; of eight pigs fed boiled cotton seed, two died; and of ten pigs fed cotton-seed meal, five died; of eight pigs fed corn meal, all throve well. The symptoms of the poisoning are given, and also the fact that some older pigs seem to be proof against the poison. Boiling the seed seems to lessen the danger from it.

IV. COTTON-SEED MEAL FOR CALVES.

[See Page 437 and following for detailed description. Supplied upon application to the Director.]

With better methods and practices in dairying, it becomes desirable to raise calves on skim-milk. Where common methods of creaming the milk prevail, the skim-milk is good enough to grow up handsome calves and cows; but with the use of separators, the fat is so thoroughly extracted from the milk that it is necessary to replace it by the use of some convenient by-product containing an oil to replace the fat of the milk. Cotton-seed meal has been suggested for this purpose, but trials of it made at this Station led to results which do not commend the use of this meal as a supplement to separated or centrifugal skim-milk. Of three calves fed on this meal all died, but the death of one was due to licking up or eating sand. The other two are supposed to have been victims of some toxic agent in the cotton-seed meal which powerfully affects the nervous system. This apparently attacked three mature cows, probably causing the death of one.

Linseed meal, though costing too much, is yet the best by-product to supplement centrifugal skim-milk, unless sunflower or peanut cake or meal can be obtained. These products can be made in North Carolina, and the Experiment Station will make tests of them as soon as the cakes or meal and calves can be secured.

V. FEEDING SKIMMED MILK TO LAMBS.

As a means to dispose of surplus skim-milk in dairying, the fattening of young lambs has some promise. An effort was made to try this by using the "culls" of flocks brought to the city market, and which could be vastly improved for the market. A small flock of ten were tried. They were so wild that for the first week or two they would bound around the open pen when they discovered any person observing them; while the presence of a man in the pen was a sure signal for a stampede, up to the day the last one was turned over to the butcher.

These lambs were carefully handled and as much attention as possible given them without keeping them continually frightened. They were given green clover, wheat bran, oats, some corn, and separated milk. Some of the lambs learned to drink the milk readily, and if the whole flock had been tame, doubtless the results would have been far better. The wildness of the lambs caused some of the milk to be often wasted. The lambs were received May 15 and 25th. Four were sent to market June 20th and five August 6th. One died. The latter was weak and poor, and the violent exertions of its fellows, whenever visited by an attendant, combined with the confinement, was probably the cause of death. The cost of lambs and food, aside from milk, were greater than the price received for the same, hence only a negative result was obtained. A further trial will be given if lambs can be found sufficiently tame for the experimental test.

Sheep raisers do not foster their own interests when they allow sheep and lambs to become as wild as were the ones fed at the Experiment Farm, and as some of these remained after weeks of daily association with a quiet attendant.

The amount of food allowed, and either consumed or trodden under foot by these lambs, was as follows:

1,462 pounds of green clover at $6 per ton	$4.386
116 pounds wheat bran at 1 cent per pound	1.16
30 pounds corn at 1¼ cent per pound	.375
127 pounds oats at 2 cents per pound	2.54
Total cost	$8.46
Net increase in value of 9 lambs	5.63
Loss	$2.83

917 pounds separated milk were also fed.

Not only was nothing received for the separated milk which was fed, but there was a loss on the other food eaten.

VI. A PIG-FEEDING TEST.

[See Page 440 and following for detailed description. Supplied upon application to the Director.]

During the winter of 1893–'94, two grade Poland-China and two cross-bred Poland-China and Jersey-Red pigs were fed weighed amounts of separated milk (centrifugal skim-milk) and bran, the aim

being to give all the pigs would eat clean. The weight and gain of each pig were determined after nine days. Then the three males were castrated, and after being fed a second period of sixteen days, only one seemed to have been checked in the rate of daily gain. The weighing was discontinued, but the pigs grew well and later on were fed through eleven ten-day periods on a series of rations calculated for a correspondent. The weights of food, average of live weights, and gains by periods were recorded throughout the whole 110 days. These rations consisted of wheat bran, cow-pea meal, and corn meal mixed in different proportions and numbered 1 to 5. Ration No. 1 was fed the first, and No. 2 the second period, and so on. No. 5 was, however, repeated in the sixth period, and No. 4 was fed in the seventh, etc., until all rations were fed twice. Then No. 5 was fed again for the eleventh period. The nutritive ratios and cost of the rations were determined. The food of one (*Black*) was mixed with hot water and allowed to stand from one feed to the next. The food of the mate to Black (*White-Tail*) was mixed with cold water so thin as to be sloppy. The food of one cross-bred pig (*Red*) was given dry. The food of the other (*Spot*) was mixed stiff with cold water. All were allowed water as freely as desired in separate troughs when they seemed to need it, in addition to the surplus separated milk which was fed in proportion to their weight at the end of the last period. Milk and meal were fed three times per day during the first period, then milk twice and meal three times per day for five periods, then only twice per day for both. Summaries have been calculated for the whole of the ten periods. The addition of sufficient cold water to the grain to make the ration sloppy gave the poorest result in gain, while the dry food gave the best result.

As to the result of the feeding, the gain in weight paid for the value of the grain fed, and paid also for the separated milk for the fifty days' feeding, from 1.4 cents to 2.03 cents per gallon. During the last fifty days there was not enough gain in live weight to pay for the grain fed, and consequently nothing was received for the milk.

VII. A SYSTEM OF FEEDING YOUNG CALVES.

[See Page 448 and following for detailed description. Supplied upon application to the Director.]

Milk from many dairy cows is too rich in butter fat to feed to calves. Besides being wasteful of butter, so much fat is not needed and may derange the digestion of the calf.

Average cow's milk contains about 3.5 per cent. fat. This amount of fat being natural to the calf does it no harm. But the calf can thrive on less fat, which may be obtained from some other source than natural mother's milk. The difference in market value between milk fat and such fat as may be supplied, may be so great as to leave a good profit for the feeder.

The substitution of skim-milk and "old process" linseed meal gruel for mother's milk by easy stages is possible, and has been accomplished at the Station with gratifying results. The young calf is taught to drink freshly drawn mother's milk at one to four days old. The gruel is prepared by scalding the meal in water, using one part of meal to seven parts of water by weight. The change is made by feeding one pound less of full milk and adding one pound of skimmed milk and one-fourth pound of the linseed meal gruel at every successive feed, if the calf appears well and digestion is not impaired. Calves should be closely watched and the amount of gruel or food varied to suit the individual. A few ounces of ground oats and good fine hay should be kept within the calf's reach at all times until it eats both, then regular feeds should be supplied the same as of milk and gruel. A little green food may be offered, if possible, or if in summer the calves may be turned into a small shady pasture.

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[The complete bulletin contains thirty-four pages, and the subject-matter can be seen by reference to the table of contents on page 431. Persons who do not receive pages 433-450 can be supplied by making application to DR. H. B. BATTLE, Director, Raleigh, N. C.]

COTTON-SEED MEAL FOR PIGS.

[For a summary of this article, see Page 426.]

The first pigs fed at the Experiment Farm were two boars purchased May 22d, 1891. At the time of purchase the pigs weighed 24 and 26 pounds respectively. They were fed the separated milk (the skim milk which came from the separator), waste from cow mangers, and occasionally green weeds, up to July 20th, when both were castrated. The pigs grew well and were both healthy and strong. The feed was continued practically the same as above until September 15th, the pigs consuming what remained unsold of the milk, and were seldom fed any feed other than waste from cows or weeds from the field up to the latter date. The rates of growth during this period may be noted by weights taken at the several dates noted below:

	May 22d.	June 11th.	July 21st.	July 31st.	Aug. 10th.	Aug. 22d. Av. 3 wts.	Sept. 14th.
No. 1	24	31	64	66	75	82⅓	88
No. 2	26	35	65	66	79	83⅓	91

During September a correspondent enquired about feeding cotton-seed meal to pigs, horses, and mules. There were no experiments then made that we knew of, and hence it was determined to feed cotton-seed meal to one of these pigs. They were separated and given the following daily rations September 15th, 1891, for period I:

No. 1—
- 12½ pounds separated milk.
- 2 pounds wheat bran.
- 4 ounces cotton-seed meal.
- Some green food was given at noon.

No. 2—
- 12½ pounds separated milk.
- 2 pounds wheat bran.
- 4 ounces corn meal.
- Some green food at noon.

No. 1 left some waste for six days and No. 2 for only two days, after which all the food was consumed until the corn and cotton-seed meals were increased October 5th. On this date the milk was dropped in order to have more meal eaten. The rations for 21 days were as follows for period II:

Pig No. 1
- 20 ounces cotton-seed meal.
- 40 ounces wheat bran.
- Green food at noon, consisting of weeds and earth pulled with the weeds.

Pig No. 2
- 20 ounces of corn meal.
- 40 ounces of wheat bran.
- Green food, consisting of weeds, at noon.

These rations were so nearly consumed by both pigs that no waste was left, except on the 14th, 15th, and 16th days two pounds of waste were noticed from No. 1. A mean of the three weights, October 22, 23, and 24, was—for No. 1, 124; No. 2, 130⅔ pounds.

For Period III. the feed was still further advanced to 32 ounces corn or cotton-seed meal and 48 ounces of wheat bran to the respective pigs. This was too much for pig No. 1, and more or less of it was left all the time. Pig No. 2 ate all of his food every day. Subtracting waste taken up from the meal fed, would leave but 2.93 pounds of both cotton-seed meal and bran consumed per day by pig No. 1 during the nineteen days this was fed. Only 48 pounds of green food was given during the first ten days of this period, and none after that time. At the end of this third period of feeding on cotton-seed meal, pig No. 1 was sick and weighed but 113 pounds. Pig No. 2 was eating all of his ration, and had gained to 136 pounds. On the nineteenth day No. 1 was fed corn.

For Period IV. both pigs were fed corn and wheat bran in the proportion of one to two, and from the seventh day 12 pounds of separated milk was fed to each pig. No. 1 gradually recovered his health, and after two weeks ate the whole ration. During the first eleven days the waste amounted to 3.62 pounds daily, which would leave but 2.38 pounds consumed, while during the last eleven days the average consumption was 5.78 pounds. The pigs weighed 122⅔ and 150⅓ pounds respectively at the end of this period.

Period V. was a return to cotton-seed meal ¼, with wheat bran ¾ in the ration for No. 1; and corn meal ¼, with wheat bran ¾ in the ration for No. 2. Twelve pounds of separated milk was fed to each daily. Except for 56 ounces of milk and meal waste from No. 1 during the first days, all was consumed. Then, as the pigs were approaching maturity, and it did not seem desirable to sacrifice pig No. 1, as might be done by continuing cotton-seed meal in his food, both pigs were fed eleven days more in Period VI. on a ration like that for No. 2 in Period V., when they were butchered at the close of Period VI.

Weights of the pigs at the close of the various periods, and dressed weights at the close of the experiment, were as follows:

	Weight before cotton-seed meal was fed.	End of Period I.	End of Period II.	End of Period III.	End of Period IV.	End of Period V.	End of Period VI.	DRESSED WEIGHTS.	
								Pounds.	Per cent. of live wt.
Length of period in days	------	20	21	19	22	10	11	------	------
Pig No. 1	88	------	124	113	122⅔	134.8	146	104	71.21
Pig No. 2	91	------	130⅔	136	150⅓	169.2	171	126	73.68

Feeding this kind of pigs was unprofitable. The cost of the pigs exceeded their value at every step of the feeding, if the separated milk is considered worth two cents per gallon. This, it should be observed, was with well fed native or "piney-woods" stock. The two pigs were fed 3,529½ pounds, equal to 441 gallons, of separated milk, up to September 15th. From that time to December 26th, 1,296½ pounds, or 162 gallons, were fed.

This, at 2 cents per gallon, equals		$12.06
Original cost of pigs, $2 each		4.00
Total cost for pigs and milk		$16.06
Selling price of pigs, 7c. per pound, dressed weight—		
No. 1, 104 pounds, at 7c	$7.28	
No. 2, 126 pounds, at 7c	8.82	
		$16.10

Cost of meal fed, by this statement, would be lost. But a restatement may be made, so that a fair valuation will be placed on the meal, and show what the milk would bring when sold to this kind of hog:

	No. 1.	No. 2.
Cost of pigs	$2.00	$2.00
Wheat bran fed, 297½ pounds, at 1c	2.975	2.975
Corn or corn meal fed, at 1½c., 56	.60	1.665
Cotton-seed meal fed, at 1⅛c., 77½	.927	----
	$6.602	$6.64
Value of dressed weight as above	7.28	8.82
Balance to pay for milk	$ .68	$2.18

This is 2.1 gallons for 1 cent, or a little less than ½ cent per gallon.

As the result of feeding cotton-seed meal, it may be stated that 4 ounces were fed per day with 32 ounces of wheat bran for twenty days, and 20 ounces per day of cotton-seed meal with 40 ounces of wheat bran for the following twenty-one days were fed and nearly all consumed by a hearty pig, without faltering; but when 2 pounds per day were fed, the pig refused to eat so much, and became sick on what was eaten, but recovered on a corn diet. This seemed to emphasize that cotton seed and cotton-seed meal is an unsafe food for swine.

Later, the Texas Experiment Station published a bulletin, No 21, on the "Effect of Cotton Seed and Cotton-seed Meal in Feeding Hogs," in which the death of a number of pigs is recorded from effect of eating cotton seed and cotton-seed meal, as follows:

TABLE III.—Result of Feeding Cotton-Seed Meal to Pigs.

FOODS.	1891.		1892.	
	Fed.	Died.	Fed.	Died.
Raw cotton seed soaked	0	0	3	2
Roasted cotton seed	5	4	3	2
Boiled cotton seed	5	1	3	1
Cotton-seed meal	5	5	3	2
Corn only	5	0	3	0

This is a startling mortality, ten out of fifteen pigs fed on cotton seed and meal in one year's experiments died, and seven out of twelve during the next year.

The record of the experiments is followed in the Texas Bulletin by the following statement: "In corroboration of the above results for two years in succession, we have to state further that several times during the past decade the college herd of swine has suffered from attacks of apparently epidemic disease—cause not then understood—the symptoms, both before and after death, agreeing closely with the symptoms noted carefully in later tests. Since the later tests have warned us of a possible cause, we have definitely determined that in case of each and every outbreak in the college herd of swine—three separate times—sickness occurred within a period of ten weeks after the first addition daily of a very small quantity of cotton-seed meal (not cotton seed) to the slop on which the hogs were fed. As above stated, the symptoms are remarkably uniform, and, once seen, an intelligent observer will hardly fail to recognize a recurrence of the trouble.

"The first sign of sickness, appearing in from six to eight weeks after cotton-seed meal is added to the ration, is a moping dullness of the animal with a loss of appetite and tendency to lie apart. Within the course of twelve to thirty-six hours, often within a shorter time, the animal becomes restless, staggering in his gait, breathing labored and spasmodic, bare skin showing reddish inflammation, sight defective, and both the nervous and muscular systems feeble and abnormal in action. The fatal cases all show spasmodic breathing, and in many instances the animal will turn in one direction only—following a fence or building wall so closely as to strike his nose against projections in a vain endeavor to push outward in that one direction which he tries to take. If no fence or building intercept him, he may travel in a circle, large or small, according to the mildness or acuteness of the malady in his particular case. When exhausted by his efforts the animal drops down suddenly, sometimes flat upon the belly, sometimes dropping on his haunches with his fore legs well apart to keep from falling over, almost always with the evidence of more or less acute internal pain. At death a quantity of bloody foam exudes from mouth and nostrils." Dr. Francis, Veterinarian to the Texas Station, found only negative results from post-mortem examinations and from feeding fluid-extract of cotton-seed meal by which he had hoped to concentrate the toxic principle. Under "Comments," closing the Texas Bulletin, we extract the following remarks: "In the tests for 1892, the medium and small-sized shoats * * * were the ones which suffered most; the large-sized shoats * * * resisting its effects and coming safely through." "Some hogs resist the poison and are practically cotton-seed proof." Fewer and later deaths with boiled seed "would indicate that thorough boiling has the effect to lessen danger in the use of cotton seed for hogs."

COTTON-SEED MEAL FOR CALVES.

[For a summary of this article, see Page 427.]

Dairymen have long known that linseed meal will grow calves in good form when fed with skim-milk. Flax is not a common crop in North Carolina or the South, and the linseed oil mills being situated so far North or West, the addition of freight charges to the price of the linseed meal makes it costly for feeding purposes.

But there is an article at hand, cotton-seed meal, which, if safe to feed to calves, or can be so prepared as to take the place of linseed meal, can be fed by Southern dairymen at a cost from two-thirds to three-fourths the cost of linseed meal. To test the availability of cotton-seed meal, which is the richer food, as a substitute for linseed meal, it has been fed to several calves in separated milk with the results detailed below. So far, results do not show that a general change to this meal for calves is desirable.

Cow Calf from Cow No. 17.—Cow and calf received Dec. 13, 1893, on trial. Calf donated by Mr. Chas. Crawford for this experiment. Calf was taken from cow at once and taught to drink warm separated milk. Dec. 17 and 18 one ounce of cotton-seed meal was put in feed for four times. Dec. 24 one and one-half ounces cotton-seed meal were put with each of two daily feeds of six pounds of separated milk. This was continued until the 31st, when the cotton-seed meal was reduced to $1\frac{1}{2}$ ounce on account of waste. On Jan. 7th another advance was tried for that day only. The calf remained bright and active and was growing at the rate of .85 pound per day. Several other trials were made in increasing both the cotton-seed meal and the milk, until from January 16th to 29th inclusive, four ounces of the meal were consumed, with 15 and 16 pounds of milk daily. On the 30th and 31st, the feed was 5 ounces per day of meal and 16 pounds of milk. The total of both milk and meal consumed in January were $433\frac{1}{4}$ pounds of milk and $7\frac{1}{16}$ pounds of meal. The calf gained 32.83 pounds in weight during this month and was fat, bright and active the whole time. The increase of meal was stopped at 6 ounces per day for the first three days of February, then for three days it was 8 ounces. Hay was fed to this and a smaller calf occupying the same stall as needed during January, in half, three-quarter and one pound amounts This calf died very suddenly on the night of February 7th–8th. A post-mortem examination was made by Dr. F. P. Williamson, who reported it as follows: * * * "The subject was female calf aged about two months. We found the brain in normal condition, also heart, pancreas, kidneys, spleen, liver and digestive canal. In the thoracic cavity was found a superabundance of fluid indicative of pleurisy. The pleura in places showed ecchy-

motic patches. The pulmonary tissue was less in volume, having lost something of usilence on manipulation."

Cow Calf "Rioter St. Helier."—The name of this calf indicates its breeding, though its dam was a grade Jersey cow. It was dropped January 9th, 1894, and was kept in the stall with the above calf, and with Polly B. 2d, mentioned below. Began to feed milk on the 14th, and mixture of fresh whole and skimmed milk on the 21st, giving 5 and 5½ pounds a. m., and 4¾, 5 and 6 pounds in the evening. During January this calf grew well. In February it gained 40½ pounds, and was bright and active all the time. The whole milk was gradually diminished, and the skimmed milk increased until during the last days of February and four days of March, when about 1 quart of the former and 5.77 quarts of the latter per day was fed, with 4 ounces of cotton-seed meal. A little hay was kept where the calf could get what it would eat. During the first three days of February, 5 ounces of cotton-seed meal were fed in the milk, after which 4 ounces were given and consumed every day except on the 9th, 12th, 13th and 15th, when there was no meal in the evening feed. In all, there had been fed 113 ounces of cotton-seed meal in thirty-two days. This calf was sprightly and active on the 4th, and died during the night of March 4th–5th. Post-mortem examination by Dr. F. P. Williamson resulted in the following report: "All organs were in healthy condition, abomasum contained cheesy mass, measuring nine inches in length by four and a half inches in breadth, and three inches thick, which weighed 31 ounces. Just back of this mass, completely blocking up the pyloric opening of the small intestine, was a quantity of sand about an inch in thickness. That this effectually stopped the passage of food, was shown by the fact that the whole of the intestine back of this was empty."

This calf had been out of the stall for a short time one day, exercising very briskly. She was not known at that time to have swallowed any foreign matter. The stall floor was of clay, bedded usually with hardwood leaves. It is possible that these carried enough sand to the floor of the stall for the calf to have licked up what was found in the stomach. The cheesy mass was the coagulated milk taken at the previous evening feed, and was not regarded as unnatural by Dr. Williamson.

Calf from Cow No. 18.—This calf came with its dam March 6th. It was then about one week old. It was taken from the cow soon after and taught to drink; then skim-milk was gradually substituted for the whole milk, and cotton-seed meal put in the milk. Four ounces per day of cotton-seed meal were put in the milk fed to the calf from March 14th to April 17th. This was not always completely eaten, and often much of it was refused. Eleven to twelve pounds of milk were fed at first, divided into two daily feeds, and this amount was increased to 14 pounds per day on March 27th, and after April 8th to 16 pounds. Hay was kept where the calf could get it if needed. The calf appeared well up to feeding time, April 17th, when it was

found lying down in a convulsion or spasm. Some froth was issuing from the mouth; died before 8 P. M. Post-mortem examination by Dr. F. P. Williamson, who reports as follows: "Calf, aged about two months, showed viscera all in normal condition; cause of death supposed to be toxic effect of cotton-seed meal."

We have also had one death of a cow which was supposed to have heen caused from feeding cotton-seed meal scraped from the grain bin, which had not been carefully cleaned at the previous emptying. She was found down in a spasm with foam issuing from the mouth, and died in a few minutes after the stable was opened in the morning.

At two different times, at long intervals, two other cows have shown very decided nervous shocks. In one case the neck was affected and the cow's head was apparently cramped to one side. She could not straighten it, and moved in a narrow circle, becoming very excited in doing so. Recovery was made, but flow of milk was checked. The other cow had paralysis of motor organs, with trembling champing jaws and foaming at mouth. Relief was obtained from a pound of Epsom salts and $1\frac{1}{2}$ ounces of laudanum. These two cases seem to have been due to the effect of cotton-seed meal, possibly from feeding old or damaged meal. Change of diet and omitting the cotton-seed meal from the ration subsequently kept both cows in normal health.

The Texas Experiment Station (Bulletin 21, page 208), commenting on the effect of cotton-seed meal on pigs, says: "Some hogs resist the poison and are practically cotton-seed proof." So far as our experience has gone, most mature cattle are not attacked by this poisonous agent. The calf-feeding so far attempted with cotton-seed meal, has been terminated by death of the subject fed, though Rioter St. Helier doubtless had stoppage at the pylorus, which caused death. From these cases of cows and calves affected, apparently from the use of cotton-seed meal, it may be stated that for calves and some mature cows cotton-seed meal, especially if old or damaged, is a dangerous food, though strong calves may be fed on it sparingly long enough to make veal of them with no apparent harm.

A PIG-FEEDING TEST.

[For a summary of this article, see Page 428.]

Shortly after putting the Station dairy in operation, it became necessary to purchase pigs to consume the skim-milk and buttermilk. A good Poland-China sow was purchased and bred to full Poland-China boar. Two pigs of this breeding (not less than seven-eighths Poland-China) have been fed in comparison with two cross-bred Poland-China and Jersey-Red pigs. The latter were purchased from a passing wagon. These were farrowed July 9, 1893. The grade pigs bred at the Experiment Farm were farrowed May 31, 1893. The older pigs were fed six to seven and one-half pounds of separated milk and three ounces of wheat bran per day on August 14, 15 and 16th. The younger pair were fed five pounds of the same milk and five ounces of wheat bran per day for the same time. All four pigs were weighed four mornings in succession. They were numbered 1 to 4, and named according to some distinguishing marks. On the morning of August 17 the average weights for each pair of pigs were as follows:

Grade pigs: Black or No. 1, 26 9/10 pounds; White Tail, No. 2, 23¾ pounds.

Cross-bred pigs: Spot, No. 4, 16⅜ pounds; Red, No. 3, 17¾ pounds.

During the next nine days the food was slightly increased and the pigs weighed every day. Following are the weights of food and gain during this period:

TABLE IV.—Food Consumed and Gains in Weight of Young Pigs.

	FOOD CONSUMED.		GAIN IN WEIGHT (POUNDS.)	
	Separated Milk. Pounds.	Wheat bran. Ounces.	Total.	Average Daily.
Black, No. 1	98¾	41	9.76	1.08
White Tail, No. 2	96¾	41	9.25	1.03
Red, No. 3	66½	36	6.25	.69
Spot, No. 4	66½	37	4.96	.56

Numbers 1, 2 and 3 were males and were castrated. Then all were fed sixteen days with the following consumption of food and gains of live weight. The weights are always averages of three or more weighings before fed on the morning of as many successive days. The last weight is taken on the morning of the next period after the one for which the gains in weight are being determined:

TABLE V.—Showing Food Consumed and Gains in Weight of the same Pigs at a Later Period.

	FOOD CONSUMED.		GAIN IN WEIGHT (POUNDS).	
	Separated Milk. Pounds.	Wheat bran. Ounces.	Total.	Average Daily.
Black	243½	94.	17.3	1.08
White Tail	243½	94.	13.8	.86
Red	172½	60.	12.3	.77
Spot	172½	60.	11.3	.71

The operation did not check the daily gain of Black. Red gained faster after it, but White Tail's rate of gain was retarded, though he continued to gain faster than did the female, Spot. The pigs fully doubled in weight in twenty-five days.

At this point the record of food and gains was discontinued. The pigs were still kept in close pens and fed the milk that would otherwise have been wasted, some weeds or grass and bran. Later in the season we were asked by a correspondent about some combinations of foods for fattening pigs. The following rations to be mixed and fed to the limit of appetite were furnished. Wishing to observe the effect of the rations, these four pigs were fed on the same as given below in ten-day periods—that is, they were fed the first ration (proposed and being fed by our correspondent) ten days. The pigs were weighed on the mornings of the 9th, 10th and 11th days. A change of food was then made and the 11th day became the first of the second period on ration No. 2. Five rations were made and each was consecutively fed for a period of ten days. After feeding the five, they were again fed, in reverse order, for periods of ten days each. Then the fifth ration was fed during the eleventh period of ten days. This feeding began December 11th, 1893, and closed March 30th, 1894.

TABLE VI.—The Various Rations Fed to the Pigs During Ten-Day Periods.

	No. 1.		No. 2.		No. 3.		No. 4.		No. 5.	
	Lbs.	Per Cent.	Lbs.	Per Cent.	Lbs.	Per Cent.	Lbs.	Per Cent.	Lbs.	Per Cent.
Wheat bran	50	33⅓	50	28.57	100	20.0	75	27.27	100	28.57
Pea meal (cow-pea)	50	33⅓	50	28.57	50	20.0	50	18.18	50	14.29
Corn meal	50	33⅓	75	42.86	100	40.	150	54.54	200	57.14
Nutritive ratio according to usual calculation, 1:	4.76		5.25		5.5		6.0		6.25	
Weight of pig for which each ration was intended (pounds)	75		125		125 to 150		150 to 200		250	
*Value of grain mixture per 100 pounds	$1 163		$1.167		$1.137		$1.151		$1.154	

*The value of each mixture was obtained by adding the cost of grinding to the cost of corn and peas. Prices were: Wheat bran, $20 per ton; corn, 60 cents per bushel; peas, 70 cents per bushel; and for grinding, 12½ cents per 100 pounds.

The pigs were fed through the first trial by J. L. Chalmers, herdsman for a time during the summer of 1893. For the eleven subsequent periods the feeding was done by Mr. C. B. Foy, a special student, and Mr. W. C. Brogden, a freshman of the Agricultural and Mechanical College.

The design was to study these rations in the order given and again in reverse order. Hence the periods were made shorter than might have been done if more pigs had been available for this experiment.

Preparation of the Food.

What preparation should be given to food for pigs? In order to collect some data in reply to this query, the rations for these pigs were prepared as follows for the whole eleven periods:

Black. The food was mixed with hot water, used sparingly and allowed to stand from one feeding time to the next. Water was given in a separate trough whenever the pig seemed to need it.

White-Tail. Food sloppy from free admixture of cold water.

Red. Food dry. The feeding trough was fitted with two compartments the same as for the other pigs, but the *dry* food was kept dry while water was kept in the other end.

Spot. Food mixed with little cold water. The consistence about the same as Black's food. Water given as needed.

The rations, except milk, were weighed out to each pig in proportions to suit its appetite during the whole experiment. In addition to the grain ration, these pigs consumed the surplus separated (separator-skimmed) milk and buttermilk. The milk was divided between the pigs at every feed in proportion to their live weight at the beginning of each period, and was all consumed.

At first the milk and meal were fed three times daily. This gave too much stable work, and after the first period the noon feed with milk was dropped. Little meal was consumed at the noon feed, and that was dropped after the sixth period.

The following is a condensed summary of food consumed, weights of pigs, with gains by periods covering the whole time of 110 days:

TABLE VII.—Food Consumed by the Pigs during each Period.

Names of Pigs.	1st Period.		2d Period.		3d Period.		4th Period.		5th Period.		6th Period. Duplicate of 5th.		7th Period. Duplicate of 4th.		8th Period. Duplicate of 3d.		9th Period. Duplicate of 2d.		10th Period. Duplicate of 1st.		11th Period. Duplicate of 5th & 6th	
	Milk. Lbs.	Grain. Lbs.	Milk. Lbs	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.	Milk. Lbs.	Grain. Lbs.
Red	115.19	56.25	118.75	76.25	161.25	65.5	138.88	73.25	120.3	69.0	104.06	56.0	108.88	47.0	103.25	40.0	122.3	38.0	113.1	34.0	114.43	28.0
Spot	144.13	63.50	148.75	91.00	188.06	77.0	170.19	86.00	152.25	76.0	130.88	76.0	152.85	58.0	126.38	80.0	155 9	78.5	145.5	63.5	152.65	60.0
White Tail	144.13	68.00	148.75	77.00	188.06	63.5	160.56	67.25	136.63	68.0	117.56	58.5	117.25	50.5	128.24	61.0	129.75	70.0	129.9	70.5	135.82	59.0
Black	158.43	70.25	163.50	90.50	215.13	77.0	181.69	75.50	152.25	80.0	137.12	80.0	132.69	60.5	132.83	74.0	156.17	85.5	151.1	80.5	164.49	72.0
Total	561.88	258.00	579 75	334.75	742.50	283.0	651.32	302.00	561 5	293.0	489.62	270.5	511.67	216.0	490.70	255.0	564.12	272.0	539.6	248.5	567.39	219.0

TABLE VIII.—Average Weights of Pigs at the Beginning of the Experiment, and at the end of each Ten-day Period, with the gain in Weight for each Period.

Names of Pigs.	Weight at Beginning of Experiment. Lbs.	End of 1st Period.		End of 2d Period.		End of 3d Period.		End of 4th Period.		End of 5th Period.		End of 6th Period.		End of 7th Period.		End of 8th Period.		End of 9th Period.		End of 10th Period.		End of 11th Period.	
		Live Wt. Lbs.	Gain Lbs	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.	Live Wt. Lbs.	Gain Lbs.
Red	75.5	96.2	20.7	118.0	21.8	132.7	14.7	151.0	18.3	162.7	11.7	178.5	15.8	188.8	10.3	197.0	8.2	212.7	15.7	218.3	5.6	220.7	2.4
Spot	96.5	121.2	24.7	141.3	23.1	164.0	19.7	185.7	21.7	201 7	16.0	222.2	20.5	232.5	10.3	253.7	21.2	264.7	11.0	279.7	15.0	282.7	3.0
White Tail	97.5	118.5	21.0	135.7	17.2	147.7	12.0	165.7	18.0	180.0	14.3	194.2	14.7	209.0	14.3	218.0	9.0	235.8	17.8	246.8	11.0	253.0	6.2
Black	105.0	132.3	27.3	154.6	22.3	171.7	17.1	190.7	19.0	207.3	16.6	226.3	19.0	238.7	12.4	254.7	16.0	279.8	25.1	291.2	11.4	297.5	6.3

From the method of calculating the milk to the live weight of the pigs, its effect should have been as near equal as possible on all the pigs; hence our interest centers on the amounts of the mixed grain required, in addition to the milk, to produce a given amount of gain in weight. These may be shown for each period in pounds of grain mixture required for one pound of gain in live weight, as follows:

TABLE IX.—Showing the Pounds of Milk and Grain Mixture Required to Produce One Pound of Gain in Weight During Each Period, and for Each Method of Preparing the Food.

		1st Period. lbs.	2d Period. lbs.	3d Period. lbs.	4th Period. lbs.	5th Period. lbs.	6th Period. lbs.
Red (feed dry)	Separated or buttermilk,	5.56	5.45	10.97	7.59	10.29	6.60
	Grain mixture	2.71	3.50	4.46	4.00	5.90	3.54
Spot (feed mixed with little water).	Separated or buttermilk,	5.83	6.44	9.55	7.84	9.52	6.38
	Grain mixture	2.57	3.94	3.91	3.96	4.75	3.71
White-Tail (feed sloppy with cold water).	Separated or buttermilk,	6.86	8.65	15.67	8.92	9.55	8.00
	Grain mixture	3.24	4.77	5.29	3.74	4.76	3.98
Black (scalded with little water, mixed stiff).	Separated or buttermilk,	5.80	7.33	12.58	9.56	9.17	7.22
	Grain mixture	2.57	4.06	4.50	3.97	4.83	4.21

		7th Period. lbs.	8th Period. lbs.	9th Period. lbs.	10th Period. lbs.	11th Period. lbs.
Red (feed dry)	Separated or buttermilk,	10.57	12.59	7.79	20.20	49.75
	Grain mixture	4.56	4.88	2.42	6.07	12.17
Spot (feed mixed with little water).	Separated or buttermilk,	14.84	5.96	14.17	9.70	50.88
	Grain mixture	5.63	3.77	7.14	4.23	20.00
White-Tail (feed sloppy with cold water).	Separated or buttermilk,	8.20	14.25	7.29	11.81	21.90
	Grain mixture	3.53	6.78	3.93	6.41	9.51
Black (scalded with little water, mixed stiff).	Separated or buttermilk,	10.80	8.30	6.22	13.25	26.16
	Grain mixture	4.88	4.63	3.41	7.06	11.43

The least food required to gain one pound of live weight was during the first period, when the pigs were youngest and smallest. The same grain mixture fed, when they had grown to nearly three times the initial weight, was little more than half as effective in producing live weight as when there was less weight to be supported.

Comparing the gains from the different preparation of the grain food, it was found that where water enough was added to make the meal sloppy the gain was least, making cost in food greater per pound of live weight gained. There was more difference in the first five periods than during the last five. During the first five periods,

or fifty days, while the pigs were growing from an average weight of 93.6 pounds to an average of 205.2 pounds, the following weights of the mixed feed and milk was required to produce one pound of gain in live weight:

	Red.	Spot.	White-Tail.	Black.
Milk (pounds)	7.97	7.84	9.93	8.89
Grain mixture (pounds)	4.11	3.83	4.36	3.99
The gains in live weight for 50 days were (pounds)	87.2	105.2	82.5	102.3

During the second fifty days there was required for each pound of gain in live weight:

	Red.	Spot.	White-Tail.	Black.
Milk (pounds)	11.55	10.21	9.91	9.16
Grain mixture (pounds)	4.29	4.90	4.93	4.84
The gains in live weight were (pounds)	55.6	78.	66.8	84.

By combining the two periods in each ration as periods Nos. 1 and 10 on ration one, periods 2 and 9 on ration 2, etc., for all five rations, a mean is obtained which represents the average effect of each ration on the pig being fed in the earliest stage of the experiment, when the weight to be supported is least and the gain per pound of digested food most; and also in the last part of the experiment, when the weight is greater, and therefore more food is required for support and to produce one pound of gain. Carrying this out brings the average for each ration at the same average date for all the others. It also comes to the middle weight for the pigs, and gives as near an average between the rations in regard to these important relations as is possible to be obtained.

The following table, V, calculated from table V, expressed in terms of separated milk and of grain mixture required to produce one pound of gain in live weight, shows the relation of the five rations to each other. This is condensed in the fifth set of columns. This shows ration No. 2 to have produced one pound of gain for the least weight of food.

If reference is made to the earlier feeding when each of the pigs practically doubled in weight in twenty-five days, it will be noted that the pigs were on the same food, and were being fed, practically, *ad libitum*, and were consuming the same proportions of food as near as could be attained. This, while only an approximation, is sufficient to show that the individuality of the pigs was of small moment, and that the difference, shown in the bottom line of the table, may very reasonably be credited to the method of preparing the ration. In the table this has been marked "Difference credited to the preparation of food," and is the average of the five rations for each feed.

TABLE X.—Comparing Amounts of Rations Required for a Pound of Gain in Live Weight and Preparation of Foods.

	1. Red. Grain, dry		2. Spot. Food, Mix'd cold and stiff.		3. White-Tail. Food, mix'd cold and sloppy		4. Black. Food mixed stiff & hot, but left to cool		5. The rat'ns below produced 1 lb of gain in live w'ght for lbs.	
	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.	Separated milk.	Grain mixture.
Ration 1	12.88	4.39	7.765	3.40	9.335	4.825	9.53	4.815	9.88	4.36
Ration 2	6.62	2.46	10.305	5.54	7.97	4.35	6.775	3.735	7.92	4.02
Ration 3	11.78	4.67	7.756	3.84	14.96	6.035	10.44	4.563	8.99	4.78
Ration 4	9.08	4.28	11.34	4.795	8.56	3.635	10.18	4.425	9.79	4.28
Ration 5	8.45	4.72	7.95	4.23	8.775	4.368	8.195	4.52	8.34	4.46
Difference credited to preparation of food	9.76	4.104	9.02	4.39	9.92	4.64	9.02	4.41		

By the comparisons shown in Table VI. it is seen that the sloppy food was more expensive than that mixed stiff with water, by requiring an additional pound of milk and one-fourth pound of mixed grain to produce a pound of gain in live weight. Thus, nearly 12 gallons of milk and 25 pounds of the mixed grain would be required in addition to make a gain of 100 pounds per pig. The scalded grain left to swell and cool from one feeding to the next, and that mixed at feeding time with cold water, gave results very similar to each other in respect to the amount required to make a pound gain of live weight. The dry grain mixture, with water to drink when needed, gave a pound of gain for the least amount of grain. This was 0.3 pound less than the mixed, either cold or hot, but 0.75 pound more of milk was required. This was the most economical feeding, not only in giving the greatest gain for a given amount of food, but in requiring the least preparation. The sloppy food was the most expensive.

It may also be noted that ration No. 2 produced 1 pound of gain, on the average of 2 periods for each one of the four pigs, at a considerable less cost of both milk and grain than any other. This ration consisted of wheat bran and cow-pea meal, 1 part each, mixed with $1\frac{1}{2}$ parts corn meal. The ratio calculated for it was 1 to 5.25, but the feeding with separated milk, which is relatively much richer in protein, would reduce that ratio considerably.

In order to show what could be realized on the milk fed, and at what stage of the feeding these pigs should have been turned into pork, the following form of statement has been calculated:

TABLE XI.—Showing Value Received for Separated Milk by 50-Day Period.

	Red. (Meal, Dry.)	Spot. (Wet, but stiff.)	White Tail. (Meal fed sloppy.)	Black. (Meal Scalded and Cooked Stiff like Spot's.)
For the first 50 days.				
Value of pig at beginning of experiment, at 4 cents per pound, live weight	$ 3.02	$ 3.86	$ 3.90	$ 4.20
Value of meal mixture fed at 1½ cent per lb.	3.71	4.42	3.86	4.42
Value of milk in ration (difference between cost and value of pig at end of 50 days)	1.40	1.81	1.24	1.74
Value of pig at end of 50 days (dressed weight, worth 6 cents, calculated to dress 83⅓ per ct)	8.13	10.09	9.00	10.36
Value received in cents per gallon of milk	1.72	2.03	1.27	1.60
For the second 50 days.				
Value of pig as above	8.13	10.09	9.00	10.36
Value of meal fed at 1½ cents	2.42	4.00	3.88	4.28
Value of milk in rations (calculated as above)	0.37	—0.10	—0.54	—0.08
Value of pig at end of 2d 50 days	10.92	13.99	12.34	14.56
Value of milk per gallon in cents	0.54			
Average value of milk for 100 day's feeding	1.13	cents per gallon.		

Thus it will be seen that a small price was realized for the milk during the first fifty days. This would have been slightly increased by including ten more days, as the pigs all made gains of 1.5 to over 2 pounds daily during the sixth ten-day period For the second fifty days, loss was incurred for all but the pig fed on dry meal, and on this one not quite half a cent per gallon for the milk fed was realized. Feeding after the sixty days was at a loss. The rations produced satisfactory gains of from 1.2 to nearly 2.5 pounds per day for six periods of ten days each. Attention is called to the advantage of the repetition of the fifth ration in the sixth period at the close of fattening. Repeating the other rations should not be followed in practice, though continuing each for a few days longer would doubtless prove desirable.

A SYSTEM OF FEEDING YOUNG CALVES.

[For a summary of this article, see Page 429.]

The substitution for the whole milk for food to young calves has been commonly practiced in dairy regions for a long time, nearly every feeder having his particular way to change to skim-milk, hay-tea, flax-seed gruel, etc. More care is necessary where the fat is so thoroughly extracted as by the use of a centrifugal separator.

The change from full to skimmed milk should not be made too hastily, and more careful provision for a proper supply of fat should be made. Several years ago, while feeding a fine herd of different breeds of cattle which was grown from calfhood, a series of rations to compass this change was calculated and successfully fed. It has since been used by this Station, with some variations following the general line of changes given in the following rations:

The milk upon which the calculation was made was not so rich in fat, nor was it skimmed as clean as centrifugal separator work. The change from feeding about one gallon of unseparated milk twice daily (calves are first taught to drink freshly drawn mother's milk at from one to four days old) is made by replacing one pint or pound of whole or unskimmed milk at a feed by the same weight of the skimmed milk. This gives a regular change, and fast enough for health of the calves. With the skim-milk a gruel was fed which was made of "old-process" linseed meal by using 2 ounces of the meal to 14 ounces of scalding-hot water, or 4 ounces to 28 of water, etc., according to the number of calves to be fed. Feeding one pound less of full milk and one more of skim-milk with one-fourth pound more of the gruel every successive feed makes the change complete in a few days if the calf does well. It should be closely watched, however, and the gruel varied according to its condition, and, if desirable, the change may be suspended for one or two days at different stages. A few ounces of ground oats and good fine hay should be kept within the calf's reach at all times until it eats both; then regular feeds should be supplied, the same as for milk and gruel. Fed in this way, a skim-milk-fed calf may be grown up as fine and at less cost than if fed upon unskimmed milk.

It will be observed that these rations differ from the standard and that the ratio is narrower. 1st. The rations are successfully nourishing the calf long before it has reached the age named in the standard; 2d. The narrow ratio will be widened in practice by the calf's eating some of the hay and ground oats. Wheat bran or corn meal may be added in small amounts later, but not in sufficient amount to derange digestion. A little green food can be offered if

it can be supplied; or in spring and summer the calves can be turned into a small grass, clover or shady pasture. Slight derangements of digestion can be handled by reducing amount of feed or by adding a small amount (one tablespoonful) of lime water to each feed.

TABLE XII.—Rations fed to Calves during Four Stages with Digestible Nutrients.

	Total Dry Matter. Lbs.	DIGESTIBLE.			Nutritive Substance Lbs.	Ratio. 1 to
		Protein. Lbs.	Carbo-hydrate Lbs.	Fat. Lbs.		
First Ration.						
12 pounds whole milk	1.56	.486	.546	.456		
4 pounds skimmed milk	.40	.14	.20	.028		
2 ounces O. P. linseed meal	.113	.032	.033	.009		
Total	2.073	.658	.779	.493	1.930	3.06
Second Ration.						
8 pounds whole milk	1.04	.324	.364	.304		
8 pounds skimmed milk	.80	.28	.400	.056		
4 ounces O. P. linseed meal	.227	.064	.066	.018		
Total	2.067	.668	.83	.378	1.876	2.6
Third Ration.						
4 pounds whole milk	.52	.162	.182	.152		
12 pounds skimmed milk	1.20	.42	.60	.084		
6 pounds O. P. linseed meal	.341	.096	.099	.027		
Total	2.061	.678	.881	.263	1.822	2.7
Fourth Ration.						
16 pounds skimmed milk	1.60	.56	.80	.112		
8 ounces O. P. linseed meal	.454	.128	.132	.036		
Total	2.054	.688	.932	.148	1.768	2 nearly

The change of ration for a calf was calculated in four stages, which are given above. These can be relied on where the separator is *not* used. The chief difference between "skimmed" and "separated" milk is in the fat, the "separated" milk contains only about one-third as much as the skimmed milk; therefore, where the separator is used, more linseed meal gruel will be needed to balance the ration.

The Marls and Phosphates of North Carolina

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RALEIGH, N. C.

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PREFACE.

The work of the Experiment Station from the earliest period of its existence, has embraced the chemical examination of natural deposits that might be used for agricultural purposes, as well as of other materials that could be so utilized from the by-products of other industries, and those that could be saved and used by careful management on the farm. The Station has thus been of material assistance in giving a more definite idea of the value of such materials, as well as advice to those who were perhaps unconscious of their proper use.

Since the establishment of the Station in March, 1877, many hundreds of analyses of marls and phosphates have been made. These are collected in this bulletin by Mr. F. B. Carpenter, Assistant Chemist, and such information of the location and extent of the deposits as could be gathered from our records is also inserted. A description of the geological features of the formations, together with their distribution, varieties and uses, are included. A chapter on the manufacture of acid phosphate from mineral phosphates is also appended in order to give a more perfect idea of this very important material.

The complete bulletin, the table of contents of which may be seen on the following page, will be sent to any person who receives only this preliminary notice, and who will make application to the undersigned.

H. B. BATTLE, *Director.*

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THE MARLS AND PHOSPHATES OF NORTH CAROLINA.

By F. B. CARPENTER, Assistant Chemist.

Introductory.

Of North Carolina's mineral resources there is none which is of so much interest to the agricultural community as her beds of marls and phosphates. These deposits are distributed throughout the eastern portion of the State, and belong to one of the largest formations of the kind in the world. The portions of the Cenozoic and Mesozoic eras, which include these deposits, may broadly be said to extend along the coast of the Atlantic Ocean and the Gulf of Mexico from New Jersey to Texas. While the marls are not as rich in some fertilizing ingredients as the famous green sand marls of New Jersey, and the deposits of phosphates thus far discovered are less valuable than those of South Carolina, the supply is very extensive, and if properly utilized will prove of material value to the farming community, especially in the eastern portion of the State. These deposits of phosphates and marls are in many cases so closely connected that there is seen a great variety of material, ranging from a nearly pure carbonate of lime containing a trace of phosphate to that of a high grade phosphate with only a small content of carbonate of lime. In addition to phosphate of lime and carbonate of lime, the green sand varieties contain an appreciable percentage of potash. The value of all the different deposits is largely affected by the varying percentages of sand or other worthless material which they may contain. It is the purpose of this bulletin to record in convenient form the analyses of the different marls and phosphates representing the various localities which have been investigated, together with such other information as will be useful in the selection and use for agricultural purposes.

Geological.

The earth's crust is divided into the Archæan, Protozoic, Paleozoic, Mesozoic, Cenozoic, and Psychozoic eras. The marls and phosphates discussed herein belong to the fourth and fifth of these eras —Mesozoic and Cenozoic. The Cenozoic or era of mammals, immediately preceded the Recent formation or age of man. The subdivisions of the Cenozoic era embrace three periods, *Eocene* or period of nearly extinct species; *Neocene* or period of which the species are more than half extinct; and *Pleistocene* or period of which more than half the species are still living. The Triassic and Cretaceous

periods of the Mesozoic era; the Eocene, Neocene, and Pleistocene periods of the Cenozoic era, all have representatives in the deposits of marls and phosphates.

Origin.

In former times the coast line of North Carolina was much farther inland than at present; and it is not difficult to understand how the different varieties of marl, composed as they are chiefly of shells, mollusks and other organic remains, should be found in abundance in a locality which was once the bed of the ocean. The origin of the deposits of hard, soft, and pebble phosphates, however, has been a matter of considerable discussion. Knowing that the chief constituent of bones is phosphate of lime, the presence of large numbers of fossils in these localities indicates that they may be the remains of animal life, but just how they were deposited in the present form can only be a matter of speculation. The most probable explanation of the formation of these apparent mineral deposits is deduced from the different climatic influences and terrestrial disturbances which took place toward the end of the Cenozoic era. It has been suggested that at the close of this era the waters of the ocean were probably somewhat phosphatic. The areas for the most part, where phosphates are now found, were at that time submerged, and in these shallow waters there lived myriads of shell fish, many secreting phosphate as well as carbonate of lime. Fishes of all kinds lived and died in these waters, and their bones, while mostly disappearing, served to increase the amount of phosphate of lime in the lime formation. Gradually the shores emerged from the seas, and while this was taking place came the great geological era—the glacial epoch. The cold of this epoch caused every living creature capable of moving to migrate to the southward. The strongest survived the longest. Many of these sought the swamps and warm estuaries of the Carolinas while others pushed on to Florida, in which places finally, from one cause or another, but generally from the intense cold, they perished and their bones lay there in myriads, some being still well preserved. At this time also the sea was swarming with large numbers of fish, great and small. Many of these also, driven into the warmer waters by the intense cold, died and their bones were added to the growing mass. Then came the melting of the glaciers accompanied by the very large streams which aided in making these formations in the stiller waters. The phosphate of lime in suspension was deposited as an alluvial deposit, and mixed in many cases with lime, clay and sand which were brought down by the same means. The gradual evaporation of these waters brought about the phosphate formation principally in the neighborhood of the rock cavities and fissures of large and small estuaries. These estuaries besides being swarming with life and vegetable matter, were heavily charged with acids and salts, and their continuous concentration ultimately induced different processes of decomposition and final metamorphism.

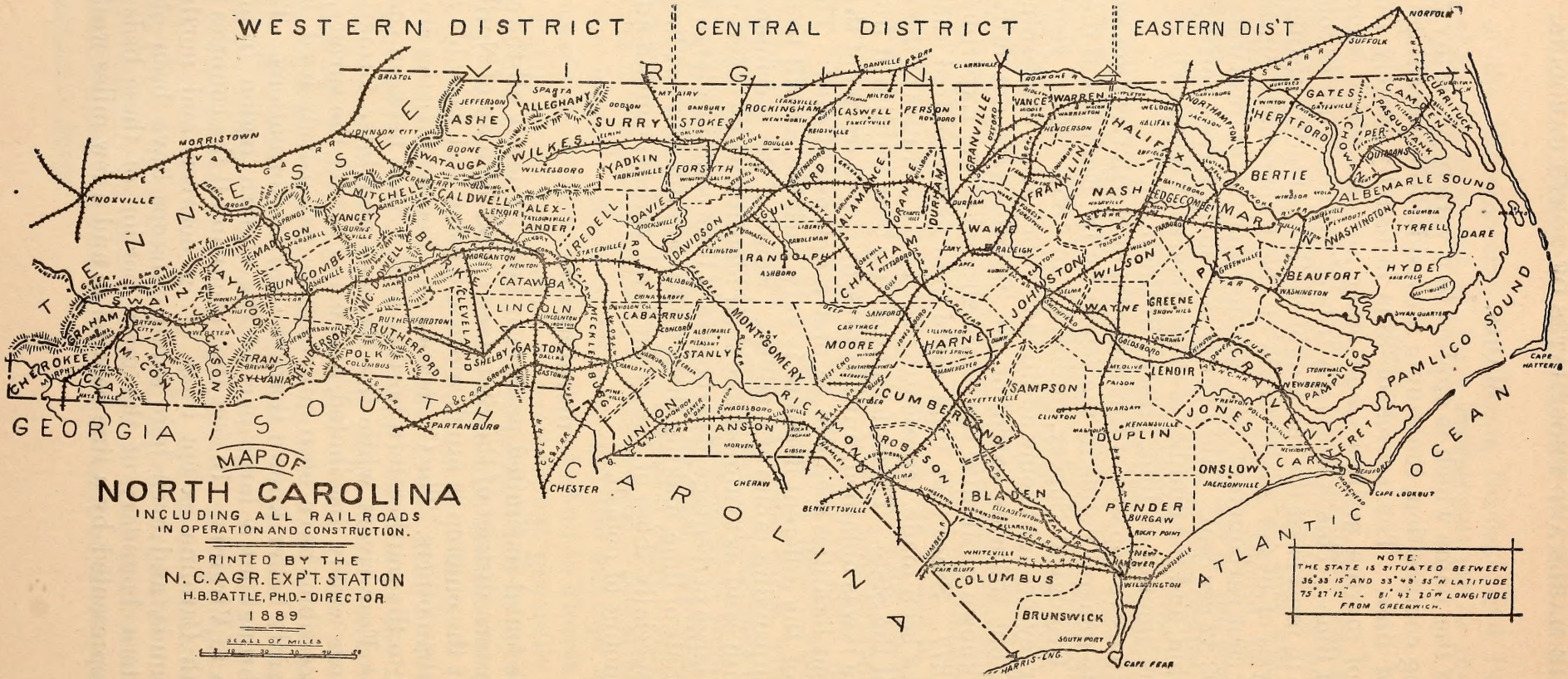
Marls.

Marl is the name which is applied to a variety of earthy deposits of varying composition, containing a considerable percentage of carbonate of lime. The source of lime is usually largely from the remains of marine mollusks and other animals which secrete carbonate of lime. This is especially true of the marls under consideration, and in most cases the remains of shells are readily distinguished. An analysis of oyster shells made at the Experiment Station gave 89.85 per cent. carbonate of lime; another analysis of fresh water shells showed 93.32 per cent. Other varieties of shells have a corresponding composition, and the number of these cretaceous remains is an indication of the amount of lime present in the marl.

The extensive deposits of this material in North Carolina were first brought to general notice in the report by Dr. Emmons of the North Carolina Geological Survey, published in 1852. Each year's work of the survey brought some additional information concerning these localities, but the wide extent of the deposits were not fully recognized or known until after the establishment of the Experiment Station in 1877. Since that time more than four hundred analyses of marl have been made, representing thirty-six counties of the eastern portion of the State. This information has been published from time to time as it was obtained, until at present the character of the marls in different localities seems to be pretty well established. The composition of the different deposits is very variable, as will be seen by the accompanying tables of analyses. Some of the specimens are so mixed with sand as to almost lose their identity, while others in addition to a large percentage of carbonate of lime contain a large amount of phosphate of lime, making them quite valuable as a fertilizer. Still others, especially those of the green sand variety, contain an appreciable amount of potash.

DISTRIBUTION.

Marl is found in limited patches or beds in nearly all the counties of the eastern district of the State (see p. 458 for map of North Carolina), but the outcrop is much more extensive and valuable in some sections than others. The Cretaceous and Eocene varieties are mostly confined to the southeastern portion of the State between the Neuse and Cape Fear rivers, while the Neocene and later formations are much more widely distributed, and being nearer the surface, and so more accessible, have been much more extensively used, and are consequently better known than the earlier formations. They are found throughout a large part of the eastern region from South Carolina to Virginia. In fact they occur in all the counties in eastern North Carolina except those lying between and north of the great sounds, and even here small outcrops have been observed. The western boundary of the main portion of these beds is very nearly represented by a line parallel to and a few miles west of the


WESTERN DISTRICT
CENTRAL DISTRICT
EASTERN DIS'T
VIRGINIA
TENNESSEE
SOUTH CAROLINA
GEORGIA
ATLANTIC OCEAN
MAP OF
NORTH CAROLINA
INCLUDING ALL RAILROADS
IN OPERATION AND CONSTRUCTION.
PRINTED BY THE
N. C. AGR. EXP'T. STATION
H.B. BATTLE, PH.D. - DIRECTOR
1889
SCALE OF MILES
NOTE:
THE STATE IS SITUATED BETWEEN
36° 33' 15" AND 33° 48' 55" N LATITUDE
75° 27' 12" - 81° 42' 20" W LONGITUDE
FROM GREENWICH.
CAPE HATTERAS
CAPE LOOKOUT
CAPE FEAR
PAMLICO SOUND
ALBEMARLE SOUND
MORRISTOWN
KNOXVILLE
BRISTOL
SPARTANBURG
CHESTER
CHERAW
BENNETTSVILLE
WHITEVILLE
BRUNSWICK
SOUTH PORT
HARRIS-LNG.
NORFOLK
SUFFOLK
ASHE
ALLEGHANY
SURRY
STOKES
ROCKINGHAM
CASWELL
PERSON
VANCE
WARREN
GATES
CAMDEN
CURRITUCK
PERQUIMANS
PASQUOTANK
CHOWAN
HERTFORD
BERTIE
HALIFAX
NASH
EDGECOMBE
MARTIN
WASHINGTON
TYRRELL
DARE
HYDE
BEAUFORT
PITT
GREENE
WILSON
JOHNSTON
WAYNE
LENOIR
CRAVEN
JONES
ONSLOW
DUPLIN
SAMPSON
BLADEN
PENDER
BURGAW
ROCKY POINT
NEW HANOVER
COLUMBUS
WILKES
WATAUGA
BOONE
ASHE
JEFFERSON
ALLEGHANY
YADKIN
FORSYTH
DAVIE
IREDELL
ALEXANDER
CALDWELL
MITCHELL
YANCEY
MADISON
BUNCOMBE
HENDERSON
TRANSYLVANIA
GRAHAM
CHEROKEE
MACON
SWAIN
JACKSON
RUTHERFORD
POLK
MCDOWELL
BURKE
CATAWBA
LINCOLN
GASTON
CLEVELAND
SHELBY
UNION
CABARRUS
STANLY
MECKLENBURG
IREDELL
DAVIDSON
RANDOLPH
GUILFORD
ALAMANCE
ORANGE
DURHAM
WAKE
CHATHAM
MOORE
LEE
HARNETT
MONTGOMERY
RICHMOND
ROBESON
CUMBERLAND
SAMPSON
JOHNSTON
GRANVILLE
PERSON
CASWELL
ROCKINGHAM
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ALEXANDER
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CATAWBA
LINCOLN
GASTON
CLEVELAND
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POLK
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MADISON
YANCEY
MITCHELL
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JEFFERSON
ALLEGHANY
SPARTA
DANVILLE
ROANOKE R.
CLARKSVILLE
HENDERSON
OXFORD
HILLSBORO
GREENSBORO
HIGH POINT
LEXINGTON
SALISBURY
STATESVILLE
MORGANTON
NEWTON
HICKORY
LENOIR
MORGANTON
MARION
ASHEVILLE
BREVARD
HENDERSONVILLE
SYLVA
WAYNESVILLE
BRYSON CITY
MURPHY
ANDREWS
ROBBINSVILLE
TARBORO
ROANOKE R.
WELDON
ENFIELD
HALIFAX
WARRENTON
HENDERSON
OXFORD
DURHAM
RALEIGH
CARY
APEX
SANFORD
PITTSBORO
GULF
CARTHAGE
SOUTHERN PINES
ABERDEEN
WEST END
SOUTHERN PINES
PINEHURST
AURORA
WASHINGTON
BELHAVEN
COLUMBIA
PLYMOUTH
WILLIAMSTON
GREENVILLE
GOLDSBORO
MOUNT OLIVE
KINSTON
SNOW HILL
FAISON
WARSAW
CLINTON
FAYETTEVILLE
LILLINGTON
SPRING LAKE
MANCHESTER
ELIZABETHTOWN
CLARKTON
LUMBERTON
MAXTON
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WADESBORO
ANSON
MONROE
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CHARLOTTE
CONCORD
ALBEMARLE
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GASTONIA
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THOMASVILLE
LIBERTY
RANDLEMAN
ASHBORO
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KERNERSVILLE
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HIGH POINT
REIDSVILLE
WENTWORTH
LEASBURG
DOUGLAS
MILTON
DANVILLE
YANCEYVILLE
ROXBORO

Wilmington and Weldon Railroad from Halifax to Goldsboro, thence southwest in a line parallel with the coast and about sixty-five miles therefrom, terminating at a point west of Lumberton. Marl is abundant and has been more or less utilized in twenty of the counties represented in this area, and beds have been located and samples analyzed from about fifteen other counties, but the outcrops are not as extensive and useful. By referring to the tables a fair idea can be obtained of the localities in which the deposits are most extensive and their products most generally utilized.

VARIETIES.

There are several varieties of marl in these deposits, the principal of which are Triassic, Cretaceous, Eocene, and Neocene—so called from the geological formation in which they occur.

Triassic.—Includes deposits in Wake County and southwestward. They are limited in extent and are not much used.

Cretaceous.—Includes the green sand formation, and occurs in the southeastern part of the State between Cape Fear and Neuse rivers, and is of the same formation as the celebrated green sand of New Jersey, but not as valuable because having a smaller percentage of green sand owing to the large admixture of foreign material. In New Jersey the average percentage of green sand is from fifty to ninety, while that of North Carolina is only from five to ten per cent. The outcrop is also comparatively small, so that for agricultural purposes the other varieties are of more practical importance.

Eocene.—This marl occurs in about the same locality and is found overlying the green sand. It is readily distinguished from the other by its outward appearance. The color is white or else a light drab or cream color, and where examined the fragments of shells or other organic remains are quite noticeable. The percentage of carbonate of lime in this marl varies from 40 to 90 per cent.

Neocene or *Shell Marl.*—This is much more abundant and more widely distributed than either of those previously mentioned. It is found in more or less abundance in nearly all of the eastern counties of the State, and is readily distinguished from the other varieties in that it is largely composed of undecomposed shells. The composition is very variable, containing on the average a less percentage of carbonate of lime than Eocene on account of the greater admixture of impurities. Some samples contain as high as 90 per cent. of sand, while others do not contain more than 10 to 25 per cent.

USES.

Marl forms a very valuable addition to our list of natural fertilizers. While its fertilizing value is increased very largely by the percentage of phosphate of lime or potash, its chief constituent is carbonate of lime, which gives to it its main value. Lime, when applied to the soil, affects it in different ways, and in its use there are several

points to be considered. It may be regarded somewhat as a direct plant food, as well as a chemical agent acting upon the organic matter of the soil and the various other mineral constituents of which the soil is composed. Another very important property which lime possesses is its mechanical action upon the soil. If applied to a light, sandy land it makes it less porous and less inclined to part with its moisture. On the other hand, if applied to a wet, clayey soil it tends to make it more porous and more easily worked. Notwithstanding the fact that large quantities of lime are consumed in plant life, it is not usually regarded as a fertilizer to be added to the soil, for the reason that the soil is usually abundantly supplied with it. It, however, has the power of decomposing the compounds of potash and soda from their insoluble combinations, both of which substances are of primary importance in the growth of the plant. Lime also decomposes organic matter in the soil and renders it available for the use of the plant. Lands which are very rich in vegetable matter have a tendency at certain times to produce organic acids in large quantities, forming what are commonly termed sour lands. Lime applied to such lands not only corrects the acidity but liberates a large amount of valuable plant food.

The term *lime* is usually applied to the caustic or burnt lime. Marl or limestone contains carbonate of lime, which can easily be changed to the caustic state by burning, but for agricultural purposes it may not always be remunerative or desirable. It takes much labor and expense to burn large quantities of marl, and where it can be made to serve its purpose it is desirable to apply it without burning. In many respects the two forms may be said to accomplish the same results, but not to the same degree of usefulness on different classes of soil. Generally speaking, caustic or burnt lime is the best for heavy clay soils and those rich in organic matter, while carbonate of lime does better for light soils and those containing little organic matter. From what has been said regarding the strong action of lime on the soil, it will be seen that considerable care must be exercised in its use. If too much is used it will cause a deterioration of the land, and is worse than nothing; and it will also be observed that soils rich in organic matter will require more than those destitute of the same. No definite rule can be laid down as to the amount to use, owing both to the great variety of soils and the variable composition of the material in question. The ordinary way among those who use it, is to apply from 100 to 200 bushels to the acre, but of course this can only serve as a guide in a general way, for the quality of the marl is so variable. One application is sufficient for several years. Besides the uses already spoken of, marl forms a very valuable material for composting, and the manufacture of some home-made fertilizers.

Phosphates.

Phosphoric acid combines in nature with several different bases, but the most common combination of this kind, as well as the

most valuable for agricultural purposes, is the tricalcium phosphate ($Ca_3 P_2 O_8$), or what is commonly known as phosphate of lime. Deposits of this material of more or less commercial value and importance have been located and worked in Virginia, North Carolina, South Carolina, Alabama, Georgia, Tennessee, and Florida, and it is probable that there are other beds not yet discovered. If no further discoveries should take place for years to come, the vast beds of South Carolina and Florida are capable of supplying the needs of the world far into the future.

Coprolites have been known for many years to occur in the marl deposits of the East and in the Triassic regions in Rockingham, Stokes, Chatham, and Moore Counties, but it was not known that phosphates existed in sufficient quantities to be of agricultural value until the deposits at Castle Hayne were discovered in 1883 through the means of this Station, after which time a small sum was appropriated by the North Carolina Department of Agriculture to be expended under the direction of the Experiment Station for the purpose of having a thorough survey made of the various phosphate localities. Explorations were accordingly conducted during the year 1884, at which time a large number of beds were examined and samples analyzed. Since that year the Experiment Station has assisted land owners who were interested in the development of these natural resources upon their property. A large number of analyses of samples representing different localities have accordingly been made, the results of which are incorporated in the annexed tables.

DISTRIBUTION.

The most important phosphate deposits in North Carolina, as has just been referred to, thus far investigated, lie in a belt fifteen to twenty miles wide, extending from the South Carolina line northeastward with the trend of the coast to the Neuse river It runs through the counties of Columbus, Bladen, Sampson, Duplin, and includes a small part of Pender, Lenoir, Jones, and Onslow. A conglomerate of phosphatic nodules and marl, less rich in phosphate than the preceding, lies just below this and extends southward through Pender and New Hanover Counties nearly to the coast. These nodules differ very much in size, and vary in color from a light gray to a greenish black.

The following extracts are taken from the report for 1885 of this Station, and give a good resumé of the occurrence of phosphates in North Carolina:

"The following resumé of the report referred to was made by Dr. David T. Day, for the Report of the United States Geological Survey on the Mineral Resources of the United States, 1883 and 1884. It will be useful as an epitome of our work and as the estimate of an outside expert upon the industrial value of our North Carolina phosphates:

"'Within the years which this report is intended to cover (1883

and 1884) discovery has been made of beds of phosphate rock in North Carolina of such extent that they must inevitably become an important factor in the phosphate industry of the United States. The discovery is due to Dr. Charles W. Dabney, Jr., Director of the Agricultural Experiment Station of North Carolina, and it is from the reports of this institution that the following account has been condensed. The beds of marl common in Virginia are also found in many counties of North Carolina. It has been known for many years that corpolites and fish teeth may be found at the bottom of this marl. They are mixed with shells and rounded pebbles of quartz. They have been noticed occasionally in such quantity that suggestions have been made in several geological reports as to their practical value for fertilizers, but they have remained untouched until now, although the associated marl has been dug for manuring adjacent land. This was the state of knowledge in regard to them from 1852 to 1883. In the winter of 1883 Dr. T. D. Hogg took a phosphatic specimen to the Experiment Station at Raleigh for examination. The specimen came from a farm at Castle Hayne, New Hanover County. It was followed by another specimen from the same county, near Rocky Point. Both consisted of a conglomerate in which phosphatic nodules, sharks' teeth, shells, etc., were bound together by a cement of carbonate of lime. Soon after this, Mr. Levi Moore and Col A. M. Faison sent samples from another part of the State, Sampson County, which bore more the character of phosphate rock. Brief explorations of these localities were made and so much interest was awakened that many samples were sent to the Station for analysis. The results showed that numerous deposits of phosphate rock exist in Sampson, Duplin, and Onslow Counties. This information was obtained in the first year after the earliest intimation had been received of the existence of the phosphate rock. In January, 1884, a surveying party was sent out, and the following account of its operations gives the basis upon which the subsequent opinion as to the practical value of the North Carolina phosphates is based. The phosphate localities lie in a belt fifteen to twenty miles wide, extending from the South Carolina line northeastward with the trend of the coast to the Neuse river, and with its southeastern boundary twenty to twenty-five miles from the coast line. It runs through the counties of Columbus, Bladen, Sampson, a corner of Pender, through Duplin, and includes a small part of Lenoir, Jones and Onslow Counties. It was the work of the first survey party to establish these limits by examining all the deposits and forming a crude estimate of the situation of each bed as well as the quality and quantity of phosphate. Phosphates were found in 148 localities in the whole belt. Up to October, 1884, seventy-one of these, lying in the central part of the belt, mainly in Sampson and Duplin Counties, had been explored. The boundaries of each bed were determined by digging pits at short intervals. The thickness of the beds and the distance from the surface were measured, and the yield of

rock compared with the amount of earth which must be removed to get to it. This exploration developed the fact that the belt is a gently undulating country sixty to 120 feet above the sea level. The beds are of very irregular outline and in what are usually termed 'pockets.' They are found on small streams, usually a few hundred feet down the stream from the marl beds. They lie in the bottoms and extend into the adjoining slopes. They are found at all depths from the surface to twenty feet, which is as deep as the exploration has been pushed. The surface soil is a very sandy loam, the subsoil a stiff yellowish or reddish clay. The phosphate rock is found frequently immediately underneath a stratum of two to four feet of this clay imbedded in coarse sand. Underneath this is another stiff, fine-grained, bluish clay. The layer of phosphate rock is six to twenty inches thick. The rock is in the form of light gray to dark greenish-black lumps, which are rounded and perforated, though less so than the South Carolina rock. They vary in size from that of an orange to great slabs or cakes weighing half a ton. The seventy-one beds explored lie along the line of the Wilmington and Weldon Railroad, on either side in an area seven miles square, including Warsaw, Bowden's station, and Faison's. Fifty of the beds, varying in size from one-third acre to twelve acres, were found to yield phosphate rock containing from thirty to sixty per cent. bone phosphate, and when followed only to a depth of ten feet yielded 100 to 1,100 tons per acre, the average being 407 tons to the acre. As this gives the average of the total area explored it does not represent the best yield which would be obtained in mining by neglecting poor beds. The following is a summary of the survey's work:

SUMMARY OF EXPLORATIONS OF NORTH CAROLINA PHOSPHATE DEPOSITS.

Total number of acres explored	124.98
Total number of pits dug	790
Total cubic feet earth excavated	69,719
Total pounds phosphate rock excavated	75,495
Total calculated number tons of phosphate rock in the 124.98 acres	50,864.48
Average tons per acre	406.98

"'In order to test the actual cost of mining the rock, a bed was selected not for its richness but proximity to the railroad, and the cost involved in loading fifty tons of rock on the cars was carefully noted, as follows:

COST OF MINING FIFTY TONS OF NORTH CAROLINA PHOSPHATE ROCK.

Cubic yards earth, etc., excavated	681.
Fraction of an acre excavated	0.11
Cost of excavation	$110.05
Cost of hauling	33.75
Cost of loading on cars	2.75
Cost of ditching	18.75
Total cost	165.30

"'This experimental mining was carried on during very wet weather in March, and it is probable that the expense could be

reduced to $110 instead of $165. The following are analyses selected at random from among a large number published by the Agricultural Station:

ANALYSES OF NORTH CAROLINA PHOSPHATE ROCK.

LOCALITY.	Moisture.	Sand and insoluble matter.	Carbonate of lime.	Phosphate of lime.
	Per Cent.	*Per Cent.*	*Per Cent.*	*Per Cent.*
Farm of J. W. Best, near Warsaw, Duplin County	1.08	42.96	4.18	42.46
Farm of D. I. Woodward, near Warsaw, Duplin County	.66	30.44	6.30	53.03
Farm of D. I. Woodward, near Warsaw, Duplin County	.39	36.59	6.30	45.78
Farm of R. Middleton, 2 miles east of Warsaw, Duplin County	1.57	38.09	3.81	45.16
Farm of R. Middleton, 2 miles east of Warsaw, Duplin County	.92	28.92	2.43	57.18
Farm of G. Middleton, 2 miles east of Warsaw, Duplin County	1.73	59.47	3.12	28.19
Farm of G. Middleton, 2 miles east of Warsaw, Duplin County	1.79	51.17	5.91	37.28
Farm of Levi Moore, 4½ miles south east of Warsaw, Duplin County	.63	37.36	4.96	44.51
Farm of Mrs. R. Bowden, 1½ miles west of Warsaw, Sampson County	.....	60.58	3.43	28.88
Farm of Col. A. M. Faison, 2½ miles west of Warsaw, Sampson County	.....	39.60	3 01	46.56
Farm of A. Rich, 3 miles south of Faison's, Sampson County	.....	34.60	5.71	46.19
Capt. L. T. Hicks, 4 miles southwest of Faison's, Sampson County	.....	35.76	5.11	43.53

"'These analyses show that the composition varies within considerable limits, but also that beds can be picked out which will yield phosphates as rich as those of South Carolina. They contain small amounts of calcium fluoride, oxides of iron, and alumina.

"'As to the chance of this rock being utilized, there is nothing in the location of the beds which would interfere with its being mined for local use in the manufacture of superphosphates. The beds are all comparatively near the Wilmington and Weldon Railroad, and the test of the cost of mining has shown that rock can be put on the cars at a price low enough for the profitable manufacture of superphosphates. Considering the enormous amount of manufactured phosphates used in North Carolina, it is safe to predict that factories will soon be established to satisfy the needs of the State by home products. At present phosphates are not manufactured to any great extent in North Carolina, except at the works of the Navassa Guano Company, near Wilmington. This company is so removed from the phosphate region, and has become so well connected with other sources of phosphate rock, that it must be looked upon rather as a foreign element, and if the new beds are to be utilized it must be by

manufacturers located nearer the deposits and working in common with the miners. Such home manufacture will have the advantage of minimum freights for crude material as well as manufactured fertilizers. In regard to the possible influence of the North Carolina phosphates upon the fertilizer trade at large, it must be remembered that the question of exportation brings up the sharpest competition with the Charleston phosphates. If phosphates can be shipped from North Carolina which contain as much calcium phosphate as those of South Carolina, the competition comes upon an even footing, and that phosphate will find sale which can be delivered at least cost. The superior facilities for loading on vessels at Charleston would probably be sufficient to decide in favor of those deposits, which are directly at a deep-water harbor, while the North Carolina phosphates must be mined through woods and swamp land, requiring much improvement in the way of terminal facilities. Further, in order to compete with the South Carolina industry, North Carolina must break into well-established lines of trade involving other industries than phosphates. It has still to be shown that the phosphate deposits of North Carolina are so extensive as to become a rival of Charleston in point of quantity. If, however, they should prove equally large, the question of their utilization outside of the State is one of the time when the cost of mining in Charleston shall rise to the limit of profitable shipment in North Carolina.

"'The 'conglomerate' found near Castle Hayne and Rocky Point, in New Hanover County, is a formation different from phosphate rock. It is found at the bottom of marl beds, and consists of cemented coprolites and bones of fish. Taken as a whole, the composition of the conglomerate is given in the following analysis:

ANALYSIS OF NORTH CAROLINA COPROLITIC MARL.

	Per Cent.
Calcium carbonate	64.26
Calcium phosphate (bone phosphate)	11.16
Magnesia	.81
Potash	.40
Sulphates and chlorides	Traces.
Sand, soluble silica, oxide of iron, alumina, etc., undetermined	23.37
	100.00

"'The conglomerate is found in large beds along the northeast Cape Fear river, in Pender and New Hanover Counties. The beds are seen wherever the creeks have cut through the sand or wherever ditches have been dug, throughout a region twenty-five miles long and ten miles wide. Beginning at the south, they appear at various points about Wilmington; one mile east, at a ballast quarry, whence a lean phosphatic rock has been shipped to many parts of the world as ballast; two miles northeast, along the banks of Smith's creek; one and a half miles east, in S. W. Noble's marl pits. From this point the beds extend up the northeast Cape Fear, appearing chiefly upon the right bank of the river, and throughout the country to the east, until they disappear under the sand banks of the coast. Ten

miles north of Wilmington, in the Castle Hayne neighborhood, they attain their greatest development and come nearer the surface. They appear all along the bank of the creek here four or five feet thick, and in the fields adjoining the creek the conglomerate is found within two feet of the surface and four to five feet thick. The beds cross the river one and a half miles north of Castle Hayne, and from this point onward appear chiefly on the west side, between the river and the line of the Wilmington and Weldon Railroad. Here again they are seen on the banks of the creek and in the ditches. They are exposed to great advantage on the French Brothers' farm, three miles east of Rocky Point, where marl and limestone have been largely dug. The Messrs. French have removed the limestone for burning lime down to the conglomerate and exposed it for several acres. To the north from this point the beds are found on Durham farm, the Walker farm, across the river on Gregory's creek, etc., until they are lost in Holly Shelter and Angola Bay swamps. North of the swamps, in Duplin, Onslow and Jones Counties, the phosphates occur again [but now as phosphate rock].

"'At French's bed a tough, solid shell-limestone five to seven feet thick is found three or four feet below the surface; below this the conglomerate is two inches to two feet thick. At Castle Hayne there is either a mere skim of the limestone or none at all, covering the four to five feet of conglomerate. At the other places a layer of loose nodules is found on top of the conglomerate. At Noble's farm, near Wilmington, a bed of very soft marl two feet thick is found carrying the nodules, and a bed of hard conglomerate under this for two feet deeper. At other places, a thick bed of shell marl rests upon the conglomerate. The nodules of this conglomerate are of all sizes from a pumpkin to a bean. They are smaller about Wilmington and Castle Hayne, and larger at French's. They are of all shapes, but for the most part kidney and egg shaped. Their color is light gray to greenish black. Some are perforated, but less so than South Carolina rock. The composition varies markedly even in the same piece of conglomerate. The following is the complete analysis of one of the nodules from the conglomerate, taken at random:

ANALYSIS OF PHOSPHATIC NODULES FROM CONGLOMERATE.

	Per Cent.
Sand	43.66
Carbonate of lime	34.56
Magnesia	.86
Potash	.39
Oxide of iron and alumina	.56
Phosphate of lime	19.99
Sulphuric acid	Trace.
Chlorine	Trace.
	100.02

"'The variations in composition of the nodules from different localities, and even from the same locality, are illustrated by the following analyses:

COMPARATIVE ANALYSES OF PHOSPHATIC NODULES FROM CONGLOMERATE.

		Sand and insoluble matter. *Per Cent.*	Carbonate of lime. *Per Cent.*	Phosphate of lime. *Per Cent.*
From Castle Hayne	1	22.07	42.12	20.50
	2	33.52	20.45	33.97
	3	----------	----------	30.90
From French's farm	1	18.50	39.04	25.34
	2	20.02	42.12	22.68
From Noble's farm	1	3.25	51.34	31.59
	2	31.66	15.94	42.09

"'The average percentage of phosphate of lime in a large number of these individual nodules, separately examined, is 32. A large lot of nodules ground up together and well mixed gave 30.90 per cent. phosphate of lime. The economic relations and agricultural value of these deposits were tested this year (1884) with such good results that a company, called the North Carolina Phosphate Company, has been formed to put this material on the market. The conglomerate is very easily mined. After the two feet of earth is removed with plows and scrapers, the deposit is shattered with powder, crushed and ground. The deposits are on navigable water, and will probably be profitable.'"

Castle Hayne Deposit.—The following preliminary report on the phosphatic deposits of Pender and New Hanover Counties, which was published by Dr. H. B. Battle in the annual report of the Experiment Station for the year 1888, is here inserted as a matter of interest, showing as it does the relative proportion and quality of each stratum of the deposits examined:

"The phosphatic deposits of eastern North Carolina in the counties of Pender and New Hanover have been worked continuously during 1888 and '89, up to the period at which this report is printed, and the products have been extensively shipped and used throughout the State.

"The examination of the present status of the beds is now going on. This preliminary report will, however, only treat of the beds mined on the Castle Hayne property in New Hanover County, owned by the North Carolina Phosphate Company. These beds are located nine miles north of Wilmington, N. C., on the north side of Prince George's creek, following this creek westwardly to its junction with the North East river.

"*Bed A.* The locality of that portion of the deposit now most extensively mined is in extent, so far as known at present, about 40 acres, and lies at the eastern limit of the Castle Hayne deposit. This mine has been worked in extent averaging 350 feet by 150 feet, and 15 feet deep, though a depth of 20 feet has been reached at some points.

"From bed A has all the merchantable phosphatic conglomerate

(when ground known as 'lime phosphate') been taken, as well as the more rich phosphatic nodules at a lower depth of a later discovery. The merchantable phosphatic materials including the 'lime phosphate' and the various nodules of different grades, rich in phosphoric acid, mined for the year ending May 1st, 1889, amounted to 2,000 tons.*

"An ideal section (stated below) of this mine would give the relative proportion and quality of each stratum. These strata are for the most part horizontal, showing deposition. No. 1, which represents the top stratum, is sand averaging 3 feet in thickness. Next follows 18 inches of clay (No. 2), underlaid by 6 inches of peat (3). No. 4 is a limestone rock from 8 to 16 inches thick, running 95 per cent. carbonate of lime. Next (5) is the conglomerate furnishing the merchantable 'lime phosphate,' composed of phosphatic nodules cemented solidly by nearly pure carbonate of lime. This stratum is from 4 to 6 feet thick, averaging 5 feet. Under this phosphatic conglomerate is a layer (6) of loose nodules, running from $2\frac{1}{2}$ to 4 feet thick, with an average thickness of $3\frac{1}{2}$ feet. This layer contains a small amount of loose sand. The layer (7) immediately underneath averages only 4 inches in thickness, ranging from 3 to 5 inches. This bed is composed of smaller phosphatic nodules than is found in No. 6. Next is (No. 8) a bed of loose nodules and lime, containing very little sand, and is 18 inches thick. In practice it is found convenient to raise these strata together, and consequently after mining they are more or less mixed. No. 9 averages 12 inches thick, and contains nodules of somewhat poorer quality mixed with disintegrated lime rock and a small quantity of sand. Beneath this stratum are found pockets of solid phosphate rock, resembling very closely the phosphate rocks of Duplin County. Analysis shows this rock to contain a large percentage of sand. These pockets vary from 3 to 6 inches in thickness. Lastly, below 10, is found a solid shell rock (11) containing 95 per cent. of carbonate of lime and of unknown thickness. This stratum is extremely hard and only a depth of 18 inches has been reached. Owing to its toughness a dynamite cartridge exploded in it can only fracture a short distance from the drill hole. At a depth of 18 inches there appears to be no indication of any different substratum.

*The mine is now (1894) equipped for the shipment of 100 tons per day.

"Portions of the various strata have been analyzed at the Station with the following results:

ANALYSIS OF STRATA IN BED A.

STRATA.	Moisture.	Sand.	Potash.	Carb. Lime.	Phos. Acid.	Equiv. to Phos. Lime.
No. 4. Lime Rock	------	------	------	95.00	------	------
" 5. Hard conglomerate	------	------	.40	64.26	5.10	11.16
" 6. a. Sand and fine phosphatic nodules	------	------	.15	13.01	4.70	10.25
" 6. b. Phosphatic nodules, medium size	------	------	------	8.44	19.77	43.17
" 6. c. Phosphatic nodules, larger size	------	------	------	8.76	17.03	37.19
" 9. Phosphatic nodules excluding lime rock	1.30	29.00	------	7.98	20.35	44.45
" 10. Solid phosphate in pockets	.45	46.25	------	35.60	5.73	12.52
" 11. Shell rock	------	------	------	95.00	------	------

"Through the courtesy of C. M. Hawkins, president of the company, below is given a complete analysis of the stratum No. 6:

Moisture	1.75
Loss on ignition	4.30
Lime	27.80
Magnesia	.22
Oxide of iron and alumina	6.37
Potash	1.15
Soda	1.28
Phosphoric acid	17.27
Carbonic acid	4.00
Sulphuric acid	1.46
Silica and sand	34.40
Total	100.00

"*Bed B.* The portion of the deposit at Castle Hayne, to be called in this preliminary report "Bed B," has never been heretofore described, and has only been discovered but a short while. It is situated about 800 feet west of Bed A, and extends, as has been determined up to this time by actual pits dug, 500 yards down Prince's cre and in breadth 100 yards. It is probable that this bed extends southward across the creek. The strata are so nearly alike throughout this area that an ideal section will nearly represent the whole area. This bed is as yet not mined for merchantable purposes.

"The strata are horizontal as in Bed A, but different from the latter in the order of deposition. In Bed B the phosphatic conglomerate (No. 5) of Bed A is wholly wanting, as well as the phosphatic nodules of Nos. 7, 8 and 9, leaving only a small portion of the phos-

phate of lime existing in Bed B, much smaller indeed than is seen in Bed A.

"An ideal section of this bed will represent an average of 3 feet of sand at the surface, followed by 2 feet of clay, which is underlaid by 6 inches of peat (3). So far this section is nearly identical with the section of Bed A. But instead of having now the hard conglomerate of the latter bed there is a stratum of 4 feet on the average of phosphatic nodules intermingled with dry clay and free from sand. Finally is seen the hard shell rock (5) extending to an unknown depth.

ANALYSIS OF STRATUM 4 OF BED B.

	Moisture.	Potash.	Phos. Acid.	Equiv. to Phos. Lime.
Stratum 4, loose nodules alone	1.88	1.05	13.04	28.47

USES.

It is hardly necessary at the present day to dwell on the importance of finding means of restoring to the soils the chief elements annually taken away from them by the crops. The elements which play the most important parts in the functions of vegetation, and those which are the most liable to exhaustion in the soil, have been found to be nitrogen, phosphoric acid, and potash. Of these three important factors of plant life, phosphoric acid is by no means the least important; the quantity annually removed from the land in the United States by the cereals alone approximates the enormous amount of 2,714,595,473 pounds. The yearly cropping of the land has so reduced the available supply of phosphoric acid that the importance of an artificial supply is generally recognized, and the world's consumption of mineral phosphates and superphosphates from all sources amounts to several million tons yearly. The commercial supply in the United States is largely obtained from South Carolina and Florida; but for home consumption the North Carolina phosphates are beginning to be considerably used and might be more extensively utilized, especially in the vicinity of the deposits. The real value of these natural products for fertilizing purposes depends for the most part upon the percentage of phosphoric acid, which can only be determined by chemical analysis.

In addition to the value as established by chemical composition, there are several other items to be considered in utilizing this raw material, either as a commercial article or for home consumption, *i. e.*, the cost of mining, grinding, hauling, etc.

Before the phosphate rock can be really considered as a fertilizer it must be finely pulverized, so that the action of the various chemical agencies of the soil can make it more easily available as plant food.

Even in this form the phosphoric acid is very slowly dissolved and little commercial value is attached to it, yet if it can be obtained at small cost it will prove a very valuable addition to the fertilizer supply. The soluble form, or the acid phosphate of the trade, is made by treating this ground rock with sulphuric acid, which, having a greater affinity for the lime, combines with it to form calcium sulphate, and thus partially liberating the phosphoric acid and leaving it combined with a smaller proportion of lime, which combination is easily soluble. In this form the phosphoric acid is nearly all made available and is readily taken up by the plant. For convenience the products of these deposits can be divided into two classes: those which contain sufficient phosphoric acid for the profitable manufacture of acid phosphate for commercial use, and the lower grades which can only be profitably used in the vicinity of the production. The manufacture of North Carolina acid phosphate is now being carried on to a considerable extent compared with former years. It has been found that an article containing from 10 to 13 per cent. available phosphoric acid can be made at comparatively small cost. While the rock is not quite as high grade as that from South Carolina, it grinds readily and takes about one-third less acid, thus reducing the cost of manufacture, at the same time retaining a good percentage of phosphoric acid.

The rock thus far examined works well with acid, the reaction takes place very promptly and completely, and the mass is left in a very porous condition and therefore dries out rapidly.

The lower grades of rock and the marls containing phosphoric acid, while they cannot be profitably used in the manufacture of acid phosphate, will prove valuable for home use. The small cost at which they can be procured will doubtless make it profitable to ship them a considerable distance. They can be ground at a small cost and when applied to the land, while the fertilizing effect will be slow, the beneficial results will be noticed for a number of years. Especially is this true if they are previously composted with such organic matter as stable manure which in fermenting has a tendency to slowly decompose the insoluble phosphate of lime.

The virgin fertility of the soil of American farms is fast being exhausted, and the successful farmer is the one who takes advantage of every opportunity. In the line of fertilizers he must learn to utilize all waste products, and if there is an available natural supply at hand he will make use of it. It is hoped by calling attention to these deposits of marls and phosphates that they may be more extensively and profitably used.

DEPOSITS OF MARLS AND PHOSPHATES IN NORTH CAROLINA.

On the following pages will be found descriptions of deposits, together with tables giving analyses of some of the principal marls and phosphates which have, from the establishment of the Station in 1877 to the present, been sent to it, or collected through special surveys for examination. These results may be said to fairly represent the character of the different formations in the State thus far examined. Preceding the tables of analyses can be found such available information concerning the location, ownership, extent, and character of each deposit from which the samples were taken as would be of value in the selection and use of the material for economic purposes. The descriptions of a large portion of the phosphate beds is taken from the very complete reports of Gen. W. G. Lewis, Engineer of the Phosphate Survey conducted by the Station in 1884; while the information concerning the marl beds was taken largely from descriptions of the deposits written by the owners at the time the samples were sent. For convenience of reference the different analyses have been arranged by counties, giving in each case the name and address of the sender or owner. It is likely, however, that in many instances the properties have changed hands and the addresses of the senders will not be the same as when the analyses were made.

Description of Deposits of Marls and Phosphates.

BEAUFORT COUNTY.

3287. White shell marl, and 3288, rock containing a little marl, from the farm of Col. R. W. Wharton, of Washington. The bed is 3 feet below the surface, 3 feet thick and covers about an acre. It is located 4½ miles west of Washington.

3347. Marl sent by Col. W. A. Blount, of Chocowinity, who writes, "The bed is located on Hill's creek, about one mile from its mouth. The creek empties into Pamlico river, about six miles below the town of Washington. The specimen sent came from the side of a hill, the earth having been removed from it years ago to the depth of 6 feet. The bed of rock extends into the low grounds of the creek, and crops out on the opposite side, apparently a large deposit."

4482, Sand marl from F. S. Stickney, Yeatesville, who writes: "My farm is a clearing of 200 acres in Laurel swamp, on the north side of Pamlico river, in the eastern part of the county. All this section, bordering as it does on the Great Dismal, is a high land alluvion, beneath which there is a 3-foot strata of marl of a similar quality to the sample I send to-day."

4524. Marl sent by C. F. Warren, Washington. "Came from Mr. Sharendon's farm in this county. It is one mile east of the village of Yeatesville. The bed covers an area, as far as developed, of 30 or 40 acres. It has been tried on lands that were perfectly dead, and in consequence it produced fine crops of corn and cotton without the use of other fertilizers. This marl is found at a depth of 16 inches from the surface, and has been dug to the depth of 9 feet. How much

deeper the bed goes has not been ascertained, in consequence of the water. Is found in lumps from the size shown up to size of fist. It is found about 18 inches from the surface of the earth."

4525. Marl sent by C. F. Warren, Washington. "Came from same bed as that of No 4524. Underlies it and is found in a solid bed. This strata is about 18 inches thick."

4526. Marl sent by C. F. Warren, Washington. "Came from same bed as Nos. 4524 and 4525. It underlies No. 4525 and is in a mass of shells 3½ feet through, and is mixed with earthy substance as in sample. The shells are in a much larger proportion."

BERTIE COUNTY.

2567 and 2568. Marls from the farm of Dr. H. V. Dunston, Windsor. Found near Cashie river.

3963. Blue marl from Eden House, near mouth of Chowan river. Bed 4 feet thick and half mile long. Sent by D. Bell, Avoca.

3964. Yellow marl from same bed as No. 3963, top layer.

4903 and 4968. Marls from Hon. Francis D. Winston, Windsor.

6481. Marl from the land of Edward Bazemore, Lewiston, Snake Bite township. The deposit is about 200 yards square and is found on the banks of a small stream flowing into Wattauna swamp.

7550 and 7551. Marls from Dr. W. R. Capehart, Avoca.

8261–62. Grey and yellow marls, from T. B. Davis, Windsor. Samples sent through Hon. F. D. Winston, Windsor.

BLADEN COUNTY.

35. Marl from J. G. Blue, Elizabethtown.

2856–57. White shell limestone sent by R. H. Lyon, Elizabethtown, taken from the same bed, from a strata 3 and 4 feet thick and 25 yards in length, width unknown.

2858. Taken from the same farm, but from a different locality.

2905. Phosphatic marl from the farm of D. A. Lamont, Brinkland. The marl is found in considerable quantities in a flat country 1¼ miles from the river. Supposed to be phosphate and on this account only phosphoric acid was determined.

3150–51. Marls from W. J. Sutton, Little Sugar Loaf. Found in large quantities from 1 to 5 feet below the surface on Hammond creek and Broad branch, about 50 miles from Wilmington, on the west side of Cape Fear river.

3742. Marl from Dr. J. S. Devane, Brinkland. From "the west bank of the Cape Fear river, forming part of the river bank. It forms a continuous bed from Wilmington to White Hall, a distance of 60 or more miles. It crops out at Waccamaw Lake (14 miles), and at Brinkland has been cut through in digging a well. The darker marl is from 3 to 5 feet thick, resting on the main bed, and is softer than the marl under it. Applied it several years ago to a piece of land very poor and destitute of vegetable matter; the crop (corn) grew off well, but when the weather got warm in June it turned yellow and died. This was corrected by the addition of vegetable matter. The marl contains, also, coprolites (No. 3943). On clay soil one application of 600 to 1000 pounds has never failed to increase the product from 300 to 500 fold," etc.

3794. Marl from Dr. J. S. Devane, Brinkland. Upper formation.

4607. Lime rock from L. J. Hall, Elizabethtown, who writes: "Taken from my farm, 10 miles below this place, on the Cape Fear river. Do not think it a fair sample, as it was taken from the edge of the rock."

5618. Marl from lands of E. N. Robeson, Tar Heel. A large deposit, extending over considerable area. Is mixed with coprolites and small bones.

6173–75. Marls from K. J. Braddy, Westbrook. No. 6173 is of a dark color and overlays Nos. 6374 and 6375, which are of a yellow color.

6389. Marl from land of Mrs. Ellen P. Guion, Lyon's Landing.

6390. Phosphate rock taken from same bed as 6389. "On river bank near by small pieces of phosphate are found on the surface." Sent by Gen. W. G. Lewis, Goldsboro.

6510–12. Marls from E. N. Robeson, Tar Heel. "Taken from well when putting down sawmill."

6511. Fossilized bone from same locality as 6510.

2759. Phosphate from Black Rock, on Cape Fear river, about 15 feet below surface, immediately overlying a heavy deposit of blue marl rock cropping out. Stratum about 5 inches. There is here a stratum of rock said to be 4 feet thick, lying immediately under this marl, and projecting 15 to 20 feet into the river. Owing to high water it was impossible to inspect it or obtain a sample.

2906 and 2907. Coprolites from D. A. Lamont, Brinkland. Found on the west side of the Wilmington-Fayetteville road, and about 50 yards from the same on a branch. The bed shows itself again about half a mile off.

3743. Coprolite from J. S. Devane, Brinkland. Found in marl No. 3742. These are numerous in the marl at Indian Wells Landing.

BRUNSWICK COUNTY.

3275. Marl sent by Henry Addix of New Supply, who writes: "The marl bed is the property of Mr. Sylvester Dixon, and located on the western side of Lockwood's Folly river, about 3 miles from the inlet, under a high bluff of clay and sand. The east side of the bed for about 40 yards is washed by the waters of the river and the abrasion shows plainly the upper stratum of the bed. A strip below is of about an average depth of 10 feet from the water at low tide and of seemingly pure marl of more than 10 feet depth, quite like the shingle of the beach, runs the whole length of the bed on the river side, and is of easy excavation. A well about 60 yards from the river and 25 feet deep has marl at the bottom, and therefore I assume the bed runs at least 60 yards or more, from the river inland. The minimum extent of the bed is 40x60 yards. The bluff covering of the bed is from 10 to 20 feet high, but the marl under it becomes forbidden fruit, as the excavation by ordinary means would be unprofitable. There is another bed farther up the river on the eastern shore, of seemingly excellent quality and more accessible."

CHOWAN COUNTY.

4297. Shell marl sent by Dr. J. M. Hayes, Barnitz. "There is an almost unlimited quantity of it on my place, having been deposited by a settlement of Indians in prehistoric times. The farmers in this locality speak very highly of its use, especially in low lands. It is deposited in a bank from 3 to 4 feet deep, covering a space of several acres, snd can be reached easily by vessels on the Chowan river. It forms part of the shore of the river in a few feet of a wharf. There is quite an intermixture of decaying Indian bones in the marl."

4485. Shell marl from same locality as No. 4297. Dr. Hayes thinks "there are at least 10,000 tons of the shells."

COLUMBUS COUNTY.

514–15. Marl sent by the Whiteville Wine Company, Whiteville. Taken from beds near Whiteville.

1615. Marl sent by Navassa Guano Company, Wilmington.

2198. Marl from the land of J. L. Manning, Peacock's Store.

2330–31. Marls from the property of Acme Manufacturing Company, Cronly.

3911. Marl from John Hinson, Chadbourn. Found on his land, 2 miles north of Grists and 2½ miles from Chadbourn, and on the edge of "Big Canady" branch about half a mile from its confluence with Dunn swamp. The blue marl is 4 feet below the surface and about 2 feet thick; then comes about a 3-foot stratum of shell marl. Bed is about half a mile long and 50 feet wide.

6547–48. Marls from the land of J. M. Shipman, near Whiteville. The deposit consists of a top layer of brown marl (No. 6547) which is mixed with blue clay. Beneath this layer is a stratum of white or shell marl (No. 6548).

8260. Marl from R. C. Applewhite, Cronly. Sent by M. Folly, Aberdeen.

8585. Marl sent by E. L. Applewhite, Applewhite.

2750. Small nodules from marl bed on farm of R. D. Sessions, 4½ miles northeast of Whiteville on the east side of a stream tributary to White marsh. Quantity seems large.

2754. Phosphate rock from same locality as last, 3 feet below surface. Stratum about 12 inches. Quantity good.

2649. Phosphate from farm of R. D. Sessions, near Whiteville. Said to be in large quantities and near the surface.

2752. Small phosphatic nodules found on bluff of marl on south shore of Lake Waccamaw. Quantity seems large. Sent by Gen. W. G. Lewis, Goldsboro, N, C.

3398. Phosphate rock from D. S. Cowan, Robeson.

CRAVEN COUNTY.

278. Limestone from R. A. Russel, Cobton.
428. Marl from John A. Jackson, Vanceboro.
506. Marl from Charles B. Stubbs, Vanceboro.
523. Earth from Henry Powel, Vanceboro. Mostly organic matter.
644. Marl from O. C. Nobles, Vanceboro.
721. Marl from a deposit about 2 miles from Newbern on the A. & N. C. R. R. Sent by George Allen, Newbern.
1119. Marl from Biddle place on Neuse river.
1139. Marl from George Green, Jr., near Newbern.
1297. Marl from near Newbern. Sent by George Allen & Co.
1952. Marl sent by Col. J. Y. Brice, Charlotte.
2153–54. Marls from a deposit on Bachelor's creek, near Newbern. No. 2153 is from the top stratum, which is about 18 inches thick. No. 2154 is from the second stratum, thickness unknown.
2155–57. Marls from the land of D. Reid, situated on Caswell branch near Newbern. The numbers represent respectively the first, second and third strata. Thickness unknown.
2855. Marl from farm of K. R. Jones, near Newbern. Found in large quantities near surface.
2859. Marl from farm of Mallet Bros., Riverdale. Found on river bank one foot below surface. Sent by George Allen, Newbern.
2860. Marl sent by George Allen, Newbern.
3241. Marl from land of Mr. Dillard or Dunlop, sent by J. Y. Bryce, Charlotte.
4504. Marl from N. A. Pursser, Vanceboro. "This marl bed, I know, underlies or underbeds about five or six acres of swamp land. The swamp is one of Swift creek's tributaries. It has been reached in many places of the bed with an auger. The marl has been penetrated at a depth of 2½ feet with an auger. Have not made a success digging, owing to the very wet condition of the land after it was found last fall. It lies from 6 to 8 feet under ground, and no sand to bother. It is from 1¾ to 2 miles from Vanceboro. The sample I sent I do not think is a fair sample, as it was obtained from near the surface of the bed."
3767. Marl from farm of L. J. Moore, near Newbern. Inexhaustible quantities.
4204. Marl from farm of P. Fenneth, some miles below Newbern.
4652. Marl from Gardner & Chapman, Maple Cypress.
6334. Marl from William B. Lane, Newbern.
6414. Marl from the farm of Watson & Daniels, near Newbern.
6506–08. Marls from the land of J. B. Gardner, Maple Cypress. Extensive beds.
6523–28. Marls from the farm of Watson & Daniels. From beds situated on Boyce's creek, near Trent river.
8253. Marl from the land of Andrew Jackson, located on Brown's branch near the Washington main road, and about 1½ miles from Vanceboro.
8349. Blue marl, calcined and ground. From the land of G. L. Hardison, Thurman.
8351. Black marl from C. C. Kirkman, Redallia, Pitt County, who writes: "There are 75 to 100 acres in Craven County." Sent by W. H. Worth, Raleigh.

CUMBERLAND COUNTY.

1116–17. Blue and shell marls from E. J. Fuller, Fayetteville,

DUPLIN COUNTY.

456–58. Marls from W. H. Williams, Warsaw.
972. Marl from R. J. Williams, Warsaw.
1127. Marl sent by Ward Taylor, Magnolia.
1183. Marl from J. R. Faison, Faison.
2120. Marl sent by Levi Moore, Warsaw.
2835. Marl from the farm of J. H. Maxwell.
2836. Marl from same locality as 2835, found on branch near land of G. M. Maxwell.
3197. Marl sent by E. J. Hill, Warsaw.
3865. White marl from a bed on Shaking creek, owned by Dr. Matt Moore, Warsaw.

4321, 4364–65. Marls from the farm of B. Witherington. about 14 miles from Mt. Olive. Designated respectively as Nos. 1, 2 and 3. No. 1 is from a very large bed, "extends for at least 1,000 yards down the creek." No. 2 is not as extensive as No. 1, but No. 3 is from a larger bed than either Nos. 1 or 2.

4373. Marl from W. B. Southerland, Rose Hill, who writes: "It is found 2 miles southeast of Rose Hill. It is found at a depth of 1½ to 3 feet under surface; do not know how deep it is; have never dug more than 4 feet down. There are 3 different kinds; first is a fine yellow, and at a distance looks like sulphate potash; the second is the sample which appears to be of fine bones; the third is shell marl. This marl bed is on a tributary of Island creek swamp, ¾ of a mile from the mouth of branch."

4424–25. Marls from land of Stephen Graham, Kenansville.

4165. Marl from land of W. L. Hill, Warsaw.

5246. Marl from A. W. Maxwell. Resaca.

5594–95. Marls from land of G. W. Lamb, located about 1½ miles below Chinquepin, on the east side of North East river. The coarse lump (No. 5595) was from the hard top layer, which is about 3 feet thick. Underneath this is found the fine marl (No. 5595), which has been dug to a depth of 10 feet.

5647. Marl from the land of W. B. Southerland, Rose Hill. "It is found 1 mile east of Rose Hill, in Island creek swamp, also 1 mile from its source. There are 60 or 75 acres of this marl belonging to several parties, but in one bed, from 2 to 6 feet from the surface."

6146–6166. Phosphatic marls from the land of Daniel Moore, located 3½ miles from Warsaw and ¼ mile from the Warsaw and Clinton Railroad. The bed is 2 to 3½ feet from the surface, 2½ feet thick, and has an area of ¼ to ½ acres.

6435. Marl from A. D. McGowan, Kenansville. The bed is on high lands covering 6 to 10 acres. The top layer is hard and about 2 feet thick; has been dug 25 feet underneath without going through.

6465. Marl from the land of Milton Southerland, near Wallace. The deposit is 3 to 4 feet below the surface and is 5 feet thick. It covers an area of about ½ an acre. No shells are found in the deposits.

6487. Marl sent by Milton Southerland, Wallace.

6493. Marl from Daniel Moore, Warsaw.

6644–45. Marls from Dr. D. McL. Graham, Wallace.

2263. Phosphate rock from Levi Moore, 3 miles southwest of Warsaw.

2334, 2336 and 2338. Phosphate rock from R. M. Middleton, 2 miles east of Warsaw.

2335. Phosphate rock from R. M. Middleton, 1½ miles northeast of Warsaw.

2337. Phosphate from land of G. W. Middleton, 1½ miles east of Warsaw.

2339. Phosphate rock from land of Col. A. M. Faison, 2 miles east of Warsaw.

2474, *a* and *b*. Phosphates from the land of J. W. Murray, Kenansville.

2490. Phosphate from land of J. W. Best, ¾ mile east of Warsaw.

2541. Phosphate from land of W. H. Kornegay, 3 miles south of Kenansville.

2580. Phosphate from land of J. W. Best, ¾ mile east of Warsaw.

2488. Phosphate from the farm of Daniel Bowden, ¾ mile east of Bowden's Station, W. and W. R. R., and about 4 miles north of Warsaw. Found below a bed of blue marl, 4 to 6 feet below the surface. Stratum 6 inches thick.

2489. Phosphate from the farm of Arthur Weeks, ¾ mile west of Bowden's. Picked up where his well was dug.

2490. Three specimens of phosphate from the farm of J. W. Best, ¾ mile east of Warsaw and a short distance south of the Warsaw-Kenansville road. Two and a half feet below the surface, a bed of marl underneath them. On several of the ditches and branches on his farm, and only a few feet below the surface. Stratum, where these were dug, 6 inches thick.

2491. Phosphate from the farm of Col. A. M. Faison. Said to be in large quantities.

2492. Phosphate from the farm of the heirs of Rufus Bowden, 1½ miles west of Warsaw. Specimen from a marl pit 7 feet below the surface. Stratum 6 inches. About 200 feet higher up the branch, and about 8 feet below the surface, the same rock is found.

2542. Phosphate from farm of G. W. Middleton, 3 miles east of Warsaw, on Kenansville road. Found in a ditch ¼ mile north of house and 3 feet below surface, and seems to be in large quantities and very accessible.

2543*A*. Phosphate from Grove branch, on farm of R. Middleton. Found 3 feet below the surface, and gives indications of large quantity.

2543*B*. Phosphate from fish pond branch on same farm, in large quantities.

2544. Phosphate from the farm of Jesse Swinson, 6 miles northeast of Warsaw, on the Warsaw-Faison road.

2545. Phosphate from the farm of J. A. Boyd, 1½ miles east of Warsaw, and between the two roads from Warsaw to Kenansville. Found in a ditch 2 feet below the surface, in large quantities, very accessible.

2546. Phosphate from the farm of Kilby Hollingsworth, 2 miles north of Magnolia, on Magnolia-Kenansville road. Found in a ditch 3 feet below the surface, on the top of a white shell marl, and gives indications of some quantity.

2547. Phosphate from farm of L. Middleton, 5 miles east of Warsaw, on the Warsaw-Kenansville road, 4 feet below the surface.

2548. Phosphate from the farm of A. Hollingsworth, 2 miles north of Magnolir, and 1½ miles from W. and W. R. R.

2549. Phosphate from the farm of Levi Moore, 4 miles east of Warsaw, on the Warsaw-Kenansville road. Ten feet below the surface and below marl.

2550. Coprolites from the farm of R. Middleton, in the Grove branch.

2551. Phosphate from farm of R. Middleton.

2552. Phosphate from farm of A. D. Johnson, 1½ miles southwest of Kenansville, on the old Newbern-Fayetteville road. Large quantities in the bottom of ditches and 3 feet below the surface, and in some places among marl. It is black.

2553. Phosphate from the farm of G. W. McLammy, 3 miles west of Kenansville, on the Kenansville-Magnolia road.

2554. A mixture of fragments of bone, coprolites and phosphate rock, from the farm of J. B. Carr, 5 miles north of Kenansville, on the road to Faison's depot.

2555. Coprolites from the farm of A. D. Johnson, 1½ miles southwest of Kenansville, on the old Newbern-Fayetteville road.

2556. Phosphate from the farm of Col. A. M. Faison, 2½ miles west of Warsaw on the plank road. Found 3 feet below surface and 250 yards from his dwelling. Stratum about 6 inches thick. Quantity seems large.

2560. Phosphate from a ditch which divides farms of J. N. Williams and A. Blanchard, 4 miles west of Warsaw, in Duplin county, and southwest of Col. A. M. Faison's. Stratum 6 to 8 inches, and 3½ inches below surface.

2561. Phosphate found in ditch which divides farms of John Blanchard and Col. Faison, 3 feet below surface, in Duplin county. Stratum 8 inches.

2562. Phosphate found 3 feet below surface on lower edge of a hill 3 miles south of Warsaw, on east side of W. and W. R. R., on farm of W. C. Carlton, in Duplin county. Stratum 6 to 8 inches.

2563. Phosphate found 2½ feet below surface, on the farm of W. H. Windows, 2½ miles east of Warsaw, on the Magnolia road, and on east side of W. and W. R. R. in Duplin county. Stratum 10 inches.

2564. Phosphate found in a pit of blue marl 4 feet below surface, on same farm. Stratum 6 to 8 inches.

2565. Phosphate found on the surface of the side of a hill on the same farm.

2566. Phosphate from the farm of W. H. Windows, 2½ miles southeast of Warsaw. Taken from the bottom of a ditch 2 feet deep which leads from a marl pit where No. 2564 was found.

2632. Phosphate found in a ditch which divides farms of J. R. West and E. A. Merritt, 5 miles southwest of Warsaw, on south side of Stuart's creek, 3 feet below surface. Stratum 12 inches, and gives evidence of considerable quantity.

2633. Phosphate from farm of Thomas Turrence, 5 miles southwest of Warsaw, on south side of Stuart's creek, on Kenyon and other branches. Found in large quantities and nearly on the surface. Said to be a stratum of 2 feet, and a foot lower another stratum of 1 foot.

2634. Phosphate from the farm of A. West, 6 miles southwest of Warsaw, and south of Stuart's creek, on a tributary of said creek. Two and a half feet below surface in bottom of a ditch. Stratum 8 to 10 inches, and indications of some quantity.

2635. Phosphate from land of Jesse Swinson, 4 miles northeast of Bowden's. Three pits, 180 cubic feet earth excavated. Small quantity of rock.

2636. Phosphate from land of R. W. Boyette, 3 miles east of Bowden's; 2.08 acres, 86.23 tons per acre—total 179.35 tons. Ten pits, 750 cubic feet earth and 357 pounds rock excavated.

2639. Phosphate from farm of L. Aaron, 1 mile southeast of Warsaw, and adjoining farm of J. W. Best. Three feet below surface and in quantity. Stratum 8 inches.

2648. Phosphate from farm of Henry Best, 3 miles west of Warsaw, 4 feet below surface.

2650. Phosphate from farm of J. F. Croom, 1 mile east of Magnolia, on Kenansville road, 4 feet below surface, on top of marl. Stratum 8 inches. In fair quantities.

2651. Phosphate from natural well on land of M. West, 2 miles southwest of Magnolia, and near the road to Harrel's store, 12 feet below surface, under a stratum of white shell marl 4 feet thick, and on top of a solid bed of blue marl. Stratum 6 inches.

2653. Phosphate from farm of J. S. Taylor, 3 miles southwest of Magnolia.

2654. Phosphate from farm of J. R. Wells, 4 miles southwest of Magnolia. From surface; said to be in large quantities.

2655. Phosphate from farm of S. Boone (col.), 4 miles southwest of Magnolia.

2656. Phosphate from farm of A. S. Colwell, 8 miles west of Duplin road, on Iron Mine creek, 4 feet below surface, and seemingly in large quantities.

2742. Phosphate from farm of A. Rich, 2½ miles south of Faison's on W. and W. R. R., 3 feet below surface, in marl bed. Looks rich, black, massive. Quantity seems good. Stratum 8 inches, on stream tributary to Bear swamp.

2743. Phosphate from L. T. Hicks' farm, 3 miles southwest of Faison's, 3 feet below surface in marl bed, on branch tributary to Bear swamp. Quantity seems good. Stratum 8 inches. Rock black, sandy.

2745. Phosphate from C. C. Rick's farm, 2½ miles southeast of Faison's, near W. and W. R. R., 3 feet below surface in a branch tributary to Bear swamp. Stratum 6 inches. Black, quantity large.

2746, *a*, *b*, *c*, *d* and *e*. Phosphates from Lovette J. Lee, 6 miles northwest of Faison's. Nineteen pits. 1995 cubic feet earth and some rock excavated. Large quantity of Eocene marl and green sand. Light grey and white rounded nodules, some so soft that they can be mashed in the hand. Different looking specimens were analyzed separately.

2747. Phosphate from Mrs. M. E. Pass, 1 mile west of Faison's. Three pits, 360 cubic feet earth excavated. Some rock in large pieces under marl 10 to 12 feet deep.

2749. Phosphate rock from farm of Isham R. Faison, in the western suburbs of Faison's, about 6 feet below the surface, black and very massive. Stratum about 12 inches. Quantity seems good. The rock has been exposed for many years.

2751. Phosphate taken from a cut on Wilmington and Weldon R. R., ¼ mile west of Faison's. Found about 10 feet below the surface.

2757. Phosphates from cut on Wilmington and Weldon Railroad, ¼ mile north of Faison's, about 10 feet below surface. Quantity seems good. Found with marl. On a ditch tributary to Goshen swamp.

2801. Phosphates from the farm of Spiers Lanier, 18 miles southeast of Kenansville, on Halso swamp, tributary to Cypress swamp, thence tc North East river. Specimens were thrown from about 3 feet below the surface. Stratum about 2 feet thick, consisting of top layer of reddish color, middle layer dark color, and bottom layer greyish color. Seems to exist in large quantities. Mound Spring in a few feet of this phosphate bed. Marl.

2802. Phosphates from farm of John Castine, 20 miles southeast of Kenansville, found near lands of Board of Education, in Angola Bay, under marl bed, about 8 feet below surface. Stratum of marl 4 feet thick.

2803. Phosphate rock from farm of Robert James, 20 miles southeast of Kenansville, in marl bed 3½ feet below the surface, on a ditch leading into Cypress creek at the upper lakes. Stratum about 6 inches.

2804. Phosphate rock from same locality as 2803. Stratum about 8 inches.

2805. Phosphate rock from same locality as 2803. Stratum about 8 inches.

2806–07. Phosphates from land of D. J. Middleton, Warsaw.

2808. Phosphate rock from the farm of J. B. Pearce, 2 miles northwest of Warsaw, on Clinton road, in marl bed 3 feet below surface. Stratum about 6 inches, on stream tributary to Turkey creek.

2809–10. Phosphates from the land of D. I. Woodard, Warsaw.

2811. Phosphate from the land of J. W. Best, Warsaw.

2812. Phosphates from the farm of W. A. Faison, 4 miles west of Warsaw, near Turkey creek, about 4 feet below surface. Quantity unknown. Marl.

2815. Phosphate rock from farm of Wm. Boyette, about 2½ miles west of Warsaw, on stream tributary to Stewart's creek, found 4 feet below surface. Quantity fair.

2816. Blue marl from farm of Ransom Middleton, 2 miles east of Warsaw, on Goshen swamp, found 3 feet below the surface.

2817. White shell marl from same locality as 2816, found 3 feet below surface.

2821. Phosphate rock from John Frederick's, 6 miles southwest of Warsaw. Found near the surface. Quantity small. No marl.

2822. Rocks from farm of W. H. Sloan, Chinquepin, on North East river, found in ditch 3 feet below surface. Quantity large. Marl.

3100. Phosphate taken from farm of Jno. Frederick, 6 miles southwest of Warsaw.

4423. Phosphate from the lands of Stephen Graham, Kenansville.

EDGECOMBE COUNTY.

34. Marl from land owned by Hon. K. P. Battle, Chapel Hill.

502. Marl from Jesse Mercer, Tarboro.

474. Marl from J. R. Thigpen, Tarboro.

513, 626–29. Marls from James R. Thigpen, Tarboro. No. 628 marked "9 miles from Tarboro and 9 feet below surface."

660. Marl from John S. Dancy, Tarboro.

984. Marl from J. R. Thigpen, Tarboro.

1205–06 and 1619. Marls from J. R. Thigpen, Tarboro.

2618. Marl from John Lancaster, Tarboro. It is of a yellowish color, containing shells and is found in large quantities on his farm on Town creek.

2865. Marl from M. Battle, Tarboro.

3075–76. White shell and blue marls with a little mud, from farm of Capt. T. W. Battle, Rocky Mount. Too little carbonate of lime, probably, to admit of use.

3468 and 3154. Blue marl with a few white shells, sent by Thomas H. Battle, of Rocky Mount, who writes: "The beds from which I send you samples, form part of an extensive bed, extending, more or less, on both sides of the Tar, from Rocky Mount to Tarborough. The deposit is extensive on some of the river farms, but has never been found on the others. It varies in thickness from 2 to 15 feet, and lies underground 2 to 12 feet. Sometimes the area of the bed is small, sometimes several acres—the extent never having been discovered. The beds from which these samples were taken lie on the two river farms of Mrs. K. P. Battle, about 6 miles apart, where the deposits are unusually large, how large I cannot tell. It has been found at various places, ¼ to ½ mile apart, but how much lies in the intermediate spaces we do not know. These beds lie about 6 feet under the surface and are about 10 feet deep." Poor in carbonate, but has a rather unusually large per cent. of phosphate.

3539, '40, '41 and '42, were samples of marl exhibited at Edgecombe Fair in 1885, and were sent to the Station for analysis by E. V. Zoeller, Secretary, Tarboro, N. C.

4181. Marl from the lands of Hon. W. R. Cox, known as the Poke Island Farm, which is located 200 yards from Tar river, on the south side of it, and half a mile from Rocky Mount and Tarborough road, 1½ miles from Kingsboro P. O. The bed is known to extend about 27 or 30 feet, is 6 feet thick and 4 feet below surface.

4222–24. Marls from lands of C. H. Blocker, located at Fishing creek. Designated as Nos. 1, 2 and 3. No. 1 is from a soft bed 10 feet thick, No. 2 from same bed with white shells and No. 3 contains lumps of bone.

4225–26. Marls from E. B. Hodges, Tarboro.

4284. Marl, white powder, from J. M. Mayo, Whitakers. "The hard or lumpy portion lies about 3 feet under the pulverized portion. Considerable quantities of it can be had."

4394. Marl from C. H. King, Tarboro. He writes: "Is on my place about 3 miles from Tarboro. It is in a ravine, running from Tar river, extending 40 or 50 yards into the field. I have never been able to cut through the bed, but have cut 13 feet when it caved. There is a strata of light or red marl of about 3

feet over this bed. This bed extends to length of ravine and is found plentifully on the river when the water is low."

4460–61. Marls from E. B. Hodges, Tarboro.

4486. Marls from land of Dr. A. B. Nobles, Tarboro. No. 1 greyish color. "The marl sent was from my farm, 8 miles west of Tarboro, and on a small branch running up in my farm. I accidentally found that it was good by digging and putting it on some very poor land, and it filled me with surprise, and since then I have used it on several places on my farm, and always with marked results. I am sure it covers 1, 2 or more acres, and possibly several. It is about 4 feet from top of ground and about 6 feet deep, and may be more. The four samples come from same bed, but are different layers, as there seemed to be a difference in composition and color. The layers are about 18 inches thick and the No. 1 came from the top, although at the bottom it is about the same, and now I am inclined to think, after going through the soft substance, I may get some that is richer. There are cliffs all through the marl bed, but in the middle of the bed comes the dark marl, but that is not very extensive. I am satisfied that the marl has done much good to the land, as it is about the best land I have. Will make most anything."

4487. Dr. A. B. Nobles, Tarboro. No. 2 yellow marl. Came from same bed as No. 4486.

4488. Dr. A. B. Nobles, Tarboro. No. 3 shell marl. Came from same bed as 4486, third layer.

4489. Dr. A. B. Nobles, Tarboro. No. 4 marl. Came from same bed as 4486, fourth layer.

4522. Marl from T. H. Battle, Rocky Mount.

4966. Marl from G. A. Stancil. No. 1 "Is gotten about 8 feet under surface."

4967. Marl. No. 2. Found in same bed as 4966 and just below it.

5527–28. Marl from Robert Pitt, St. Lewis, who writes: "The samples of marl were dug out of a pit on my land, in a swamp leading into Town creek, situated in Township No. 10. The marl is about 4 feet from surface, 12 or 15 feet thick and seems to be 50 or 60 yards wide and about ½ mile in length." One of the samples was sent just as it came out of the pit and the other was dried and ground.

6151. Marl sent by Judge Fred. Philips, Tarboro.

6273–74. Marls from the land of E. L. Pitt. Bed is situated about 200 yards from Town creek in Township No. 10. It is 6 feet below the surface, 6 feet thick and covers 1 acre or more.

6303–04. Marls from the land of Robert Pitt, situated about 2 miles north of St. Lewis. The bed is 4 feet below the surface and is 8 to 10 feet thick.

6554. Marl from the farm of D. H. Barlow, situated 3 miles south of Tarboro.

3279. Phosphate rock from the farm of Dr. A. B. Nobles, of Tarboro. The sample was found 8 miles west of Tarboro and 3 miles from the Tarboro branch railroad, on Tyancoka swamp. The quantity is large, and marl is found with the phosphate.

3772–74. Samples of phosphate rock from Dr. A. B. Nobles, Tarboro.

FRANKLIN COUNTY.

4908–09. Marls from Rev. C. O. Durant, Youngsville.

GREENE COUNTY.

257. Marl from Dr. Ben. S. Hardy's farm, 8 miles east of Snow Hill.

258. Marl from farm of John Sullivan, on Sandy run swamp, 8 miles north of Snow Hill.

2320–22. Marls from land of Levi J. H. Mewborn, Snow Hill; 2320 "from top, ghtest colored"; 2321, "bored up with an auger, dark brownish grey"; 2322, "dug up, dark greenish."

2577. Marl from same bed as 2322, near surface.

4285. White shell marl from Hon. E. C. Blount, Willow Green.

4359. Blue marl from Jno. P. Gray, Snow Hill. "Is located on Tyson's marsh, about 5 miles southwest of Snow Hill. The extent unknown, as I have been unable to make a thorough investigation. More than ever will be dug out. I did not go through in the bed I did dig. I went down about 11 feet, 6 feet in the marl and about 5 feet before I reached it. It was bored up in several other

places. Mr. L. J. H. Mewborn has plenty of it just opposite this bed. I dug across the marsh, and had it analyzed by the Station, number of analysis 2322, contained phosphate of lime 24.82 per cent. Some places it is under rock so I cannct bore through to it."

4938. Marl sent by Jno. P. Gray. "Ploughed up in the vicinity of a hole that had been dug."

5717. Marl from B. T. Mooring, Jason.

HALIFAX COUNTY.

2571. Marl sent by R. H. Smith, Scotland Neck. Found on Kehukee creek, near land of S. W. Edwards, 4 to 6 feet below surface.

2572. Marl found on land of B. D. Webb, on Clark's branch. Sent with 2571.

2573. Marl from land of S. W. Edwards, near Scotland Neck, 20 feet below surface. Sent with 2571.

2574. Marl from land of Mr. Griffin, near Scotland Neck. Sent with 2571.

2575. Marl from land of J. B. Hall, Clark's branch. Sent with 2571.

2765. Marl from J. R. Tillery, Tillery.

3355. White shell marl from farm of Wm. E. Fenner, Halifax. The bed is about 3 feet thick, and is found on the surface, on the bank of the Roanoke river, 5 miles northeast of Halifax. The size of the bed is 75 x 100 feet. This marl is better than the average of marls, in that it has a fair percentage of phosphate.

3403. Blue marl from farm of H. B. Morse, Palmyra. Found on top of ground and no vegetation will grow on it.

4413. Blue marl from Ashley Wilkins, South Gaston. He writes: "I found the sample near (1 mile off) Palmyra, in the extreme lower edge of Halifax county, on the Roanoke river. It juts out on the river and seems to run back about a ¼ of a mile or so from the river, judging from the hill."

3763. Marl sent by E. T. Branch, Enfield. From "Creek Farm," 1 mile east of Enfield, where it is found in inexhaustible quantities.

3764. Marl from the land of John S. Gregory on Roanoke river, adjoining the town of Halifax. There is a long ridge of it lying immediately on the Roanoke river.

HERTFORD COUNTY.

2211. Marl from Tyroone Spiers, Como.

3696. Marl sent by T. H. Debnam, Winton, who writes that "the bed is 100 yards from Winton, on the lands of J. L. Anderson, 100 yards from Chowan river. Bed is about 8 feet below the surface and is supposed to be very thick."

6408–10. Samples of marl from a deposit on the Meherrin river, near Murfreesboro. Sent by John Brewer, Murfreesboro.

6456. Marl from banks of Meherrin river, on land of J. M. Wynn, Murfreesboro. Sent by E. C. Wand, Murfreesboro.

6457. Marl from a deposit on the Meherrin river, on land of J. R. Hall, Murfreesboro. Sent with 6456.

8235. Marl from farm of J. C. Drake, located in Hominy Neck township.

JOHNSON COUNTY.

2937. Marl from H. M. Bizzle, Glenwood.

JONES COUNTY.

259. Marl from farm of H. C. Koonce, on Trent river, near Comfort.

260. Marl from farm of Dr. C. J. Mattock, 3 miles above Pollocksville. Taken from a branch.

261. Marl from same locality as 260. Taken out of hill above the branch.

262. Marl from Frank Foy, Pollocksville.

653–654. Marl from A. T. Uzzell, Tuckahoe.

2425. Phosphatic marl from the farm of A. P. Barrow, Pollocksville.

2426. Marl from land of J. P. Harper, Pollocksville. Came with 2425.

2584. Rock from the land of W. A. J. Pollock, Kinston. The rock was found near Trent river and Chinquepin creek, 2 to 4 feet below surface, on top of a bed of marl.

2585–87. Marls from same locality as No. 2584, 6 inches to 10 feet below the surface. Quantity very great.

2588. Marl from same locality as No. 2584, found on surface.
4618. Marl from farm of L. J. Haughton. Sent by W. M. Jones, Kinston.
4468. Grey marl from L. Harvey, Kinston. It came from a bed situated on the farm of J. M. Wooten, 5 miles from Kinston, south side of Neuse river. "The bed is about ¾ of a mile from Caswell depot, A. and N. C. R. R. I think there are 5 or 6 acres of the marl. The bed is in Jones county, just over the Lenoir line. We have opened four pits. One pit we cut 7 feet in marl and struck no rock. The dirt covering the marl is from 2 to 6 feet deep. There are many thousand tons in the bed. The bed is connected with 112 acres of fine farming land. There are two public roads running near the bed, one about 100 yards, the other about 250 yards. Think we have 3 or 4 acres more of marl on a branch running into Cabin branch."
6405-06. Marls from the land of C. H. Foy, 8 miles south of Kinston, in Beaver Creek township. The samples were found 4 to 5 feet below the surface.
3279. Phosphate nodules found in a ditch, 2 feet below the surface, 1 mile south of Core creek station, on the new Trenton road.

LENOIR COUNTY.

433-35. Marls from S. E. Hodges, Falling Creek.
436-7. Marls from Noah Rouse, La Grange.
438. Clay marl from B. F. Herring, La Grange.
440. Shell marl from Thomas Dawson, La Grange.
645 and 658. Marls from S. J. Sutton, La Grange.
1340. Ground oyster shells from L. H. Harvey, Kinston.
1637. Marl from the land of E. S. Broadway, Kinston.
1645. Marl from E. Grady, Kinston.
2162. Marl sent by Seth West, Kinston.
2209. Phosphate rock sent by Dr. H. O. Hyatt, Kinston.
2427-35. Samples of marl taken by W. G. Lewis of the Phosphate Survey. Nos. 2427-29 were taken from the farm of J. C. Woolen, 9 miles from Kinston; No. 2430 from the farm of Gabriel Cox, south of Vine swamp; Nos. 2431-32 from farm of David Gooding, 1 mile east of Gabriel Cox; No. 2433 from the farm of Isaac Johnson, 2 miles northeast of Woodington church; No. 2434 from the farm of Fred. Jones, 8 miles from Kinston; No. 2435 from farm of J. Aldridge, near Kinston.
2478. Marl from W. B. Nunn, Kinston. Found in a swamp 3 feet from the surface. Quantity large.
2953. Marl from the farm of George Philips (col.), located about 5 miles from Kinston on Cabin branch and 1½ miles south of Neuse river. The deposit covers an area of about 5 acres and is found 4 to 5 feet below the surface. The bed is 8 to 10 feet thick.
3245. White shell marl (finely ground), sent by L. J. Moore, Kinston. The deposit is situated about 3½ miles south of Kinston, is about a mile in length and 10 to 15 feet thick.
4467. Marl from L. Harvey, Kinston.
3658. Shell marl with nodules, from Dr. H. O. Hyatt, Kinston. Taken from a bed 1 to 2 feet thick and 1¼ miles in extent. The bed is south of Kinston and 12 miles from the region explored by the survey under Gen. Lewis.
4741. Marl from A. B. Nobles, Kinston.
4837-40. Samples of marl from A. J. Kilpatrick, Kinston; 4837 is red clay of marl bed; 4838 top of marl, grey; 4839 bottom of marl shell and sand; 4840 bottom of marl bed, green sand.
6041. Marl from the farm of B. F. Sutton, situated 1 mile from the mouth of Bear creek, 6 miles below White Hall, 6 miles from La Grange and 12 miles from Kinston. The top of the deposit is very hard for 12 inches or more, but underneath this it is easily dug out. Sample was taken 6 feet from top of marl and has been dug 12 feet without going through. Quantity very large.
6162. Supposed phosphate rock from farm of J. M. Kilpatrick, La Grange.
6837. Marl from the farm of P. H. Mewborn, 10 miles south of Kinston.

MARTIN COUNTY.

2277. Marl from William Slade, Williamston.
2286. Shell marl from N. S. Peal, Williamston.

2885–86. Marl from Amos Robinson, Everett's. "The beds are situated about 12 miles southest of Roanoke river, on Tranters creek."

MONTGOMERY COUNTY.

8733. Marl received from J. W. Thompson, Raleigh. With reference to this marl J. C. Currie, Candor, writes: "The sample of marl was found a few miles west of Candor, and it is supposed that it is there in quantities."

NASH COUNTY.

681. Marl from T. P. Braswell, Battleboro.
2625. Marl from J. H. Enniss, Raleigh. Ground by Carter Pope, Battleboro.
3587. Marl from W. E. Philips, Battleboro.

NEW HANOVER COUNTY.

410–13. Marl and phosphate conglomerates from Cronley & Morris, Wilmington.
507. Marl from Charles B. Stubbs, Swift creek bridge.
508. Blue marl from Cronley & Morris, Wilmington. "Found in large quantities."
509–11. Samples of phosphate rock sent by Cronley & Morris, Wilmington.
879. Marl sent by Fred. D. Thorn, Wilmington. Taken from deposits near Wilmington.
1279. Marl from the land of D. McRae, near Wilmington.
1981, 1982 and 2029 are single nodules taken from the conglomerate at Castle Hayne.
1983. Conglomerate sent by Dr. T. D. Hogg, Raleigh.
2100–02. Phosphate nodules from the marl pits of S. W. Noble, Wilmington.
2103–04 and 2101. Samples of conglomerate from same locality as 2100.
2132. A collection of nodules ground together, from Castle Hayne.
2231. Burned rock from Castle Hayne.
2250–51. Samples of phosphate from Castle Hayne, burned, water-slacked and sifted. 2250 is the fine portion passing through the sieve; 2251 is the coarse portion left on sieve.
2333. Ground conglomerate from Castle Hayne.
2344–45. From Castle Hayne; 2344 represents nodules left on sieve after sifting; 2345 powder passing through the sieve.
2422. Phosphatic marl from Cronley & Morris, Wilmington.
3187. Phosphate rock from Castle Hayne. Sent by Colin M. Hawkins, Raleigh.
3261. Phosphate from Castle Hayne. Sent by P. H. Andrews, Raleigh.
3417–18. Phosphate from Castle Hayne. Sent by P. M. Wilson, Raleigh.
3536. North Carolina lime phosphate (the ground phosphatic lime conglomerate), manufactured by North Carolina Phosphate Co., and sent for analysis by Bernardt & Co., of Pioneer Mills.
3548. Phosphate from Castle Hayne. Sent by C. M. Hawkins, Raleigh.
3775. Ground phosphate from the North Carolina Phosphate Co., Raleigh. Conglomerate from Castle Hayne and ground at the company's works.
3795. Ground phosphate from same locality as 3775. Sent by T. Ivey Ashpole.
3854. Floats prepared at the North Carolina Phosphate Co.'s works, with Cyclone mill. Phosphate from Castle Hayne. Sent by Dr. T. D. Hogg, Raleigh.
3926. Blue marl from Castle Hayne. Sent by Dr. T. D. Hogg, Raleigh.
4234–35. Phosphates sent by C. M. Hawkins, Raleigh, from Castle Hayne.
4594–95. Phosphates sent by Marmaduke Hawkins, Raleigh, from Castle Hayne.
3930. Loose nodules from Castle Hayne. From underneath the conglomerate bed and several feet in thickness. Received from the North Carolina Phosphate Co., Raleigh.
4604–06. Ground phosphate from P. M. Wilson, Raleigh.
4884–86. Phosphate nodules from Castle Hayne; 4884 finest; 4885 medium; 4886 coarser. All sent by P. M. Wilson, Raleigh.
4933–34. Ground phosphate from P. M. Wilson; 4933 fine; 4934 coarse.
5714. Phosphate sent by C. M. Hawkins, Raleigh.
6153. Marl from the land of Mr. Bowden, near Wrightsville. Sent by H. W. Malloy, Wilmington.

NORTHAMPTON COUNTY.

3290. Blue marl from the farm of Dr. J. E. Stancill, who writes that the "bed is situated about 2 miles southwest of Margarettsville, on the Seaboard and Roanoke Railroad. It is about 250 yards in length. I have sunk the pit about 10 feet without going through the marl. I cannot tell the width, but it is considerable."

8718. Marl from the land of W. J. Edwards, Severn, known as the "Marl Hill Farm." The bed is located on the Meherrin river, 2 miles west of Severn station. "Both the blue and red varieties are to be found in inexhaustible quantities."

ONSLOW COUNTY.

2494. Rock from farm of David Sandlin, south side Cohen's creek, 3 miles northeast of Richlands.

2495. Coprolites from the farm of J. M. F. Brock, 2 miles northeast of Richlands. From bed of a ditch. Said to be in large quantities, and in Jenkins' branch very accessible.

2496. Coprolites from the farm of L. Franks, 2 miles northeast of Richlands, and north side of Cohen's creek and near White Oak swamp. Found on the surface on the side of a hill.

2590. Phosphate from the land of A. B. Carroll, located on the west side of White Oak river, 6 miles from Maysville and 10 miles from Pollocksville. Found near surface. Sent by Geo. Allen & Co., Newbern.

2818. Phosphates from farm of A. H. Rhodes, 2 miles northwest of Tar Landing on New river. Found in a branch about 4 feet below surface. Marl.

2819. Phosphates from Allen Murrill's farm at Tar Landing, New river, about 4 feet below surface. Marl.

2820. Phosphate rock from farm of Christopher Stevens, 11 miles northwest of Jacksonville. Found in side of a hill cut by country road, about 4½ feet below surface. Quantity fair. No marl, but abundance of lime rock.

2832–33. Marls found on the farm of A. B. Carroll. Located west side of White Oak river, between river and Great Pocosin. Found near surface in large quantities. Sent by Geo. Allen & Co., Newbern.

4233. Yellow marl taken from a bed on the Barry plantation, a few miles east of Richlands. Sent by Dr. J. L. Nicholson, Richlands.

6942. Phosphate from land of H. W. Nixon, 3 miles east of Topsail Sound P. O.

6464. Shell marl from the land of G. R. Venters, Green branch. It is found on the bank of New river, 4 feet below the surface and is 2 feet or more in thickness.

8623. Marl from the land of H. D. Murrill, Jacksonville. The bed is situated 5 miles south of Jacksonville, near the mouth of the southwest branch of New river. Thinks there are 10 or more acres in the deposit.

PASQUOTANK COUNTY.

4821. Marl from Col. R. B. Creecy, Elizabeth City, who writes: "From a section known as Tadmore, the most fertile part of the county, where reside the best farmers. The bed is inexhaustible, lying about 5 feet below the surface and is 10 miles square."

PENDER COUNTY.

1278–79. Limestone from French Bros., Rocky Mount, marked "From Excelsior Quarry."

2221 and 3747. Marls from the land of Nicanor Powers, South Washington, 1 mile from the Wilmington and Weldon R. R. Said to be in large quantities.

2097, 2098, 2109 and 2130. Phosphate nodules from the conglomerate at French Bros.' quarry, Rocky Point.

2099 and 2222. Conglomerates from same locality as 2097.

2223. Same as 2222 after being burned.

2250. Phosphate conglomerate from French's quarries, Rocky Point, burned, water-slacked and sifted. This is the fine portion passing through the sieve.

2251. Nodules from 2250, with considerable lime still adhering.

2657. Phosphate from farm of J. Alderman, 8 miles southwest of Duplin road, 3½ feet below surface, in a ditch on south side of Doctor's creek.

2757. Phosphate rock from farm of C. P. Moore, 5 miles northeast of Point

Caswell. Found in marl bed about 4 feet below surface. Stratum about 8 inches. Quantity apparently good. On a stream tributary to Moore's creek.

2758. Small nodules found in marl bed in same locality as 2757, 4 feet below surface. Stratum about 8 inches. Quantity apparently good.

3239. Phosphate rock sent by Gen. W. G. Lewis, of Goldsboro, from near northeast Cape Fear river, above French Bros.' quarry and on the same side of the river. The surface of the country is level, and the rock looks much like the South Carolina rock.

3526. Ground phosphate, sold as coprolite manure by French Bros., of Rocky Point. The sample was taken from the Excelsior Quarries of the French Bros.

3753. Supposed phosphate from French Bros., Rocky Point. A ledge, not a conglomerate, composed mostly of carbonate of lime.

2267–68. Phosphate rock from Geo. Z. French, Rocky Point; calcined, water-slacked and screened; 2268 is the nodules and coarse portion left on the screen.

4429. Phosphate rock from Col. Geo. Z. French, Rocky Point, who writes: "They are undoubtedly the most promising specimens yet discovered in North Carolina. Located in southeastern section of North Carolina. Not sufficiently explored to determine extent. It is probably a large bed, but it is so deep from the surface and so far from good facilities for railroad or water transportation that it is doubtful if it can be worked successfully for years to come."

4430. Phosphate rock from Col. Geo. Z. French, Rocky Point. Came from same place as No. 4429.

4536. Phosphate rock from N. W. Powers, South Washington. "It was taken from my farm on the northeast branch of the Cape Fear river, 1 mile from the W. and W. R. R., in the upper end of Pender county. The rocks lie on and near the surface of the ground and cover 100 or 200 acres of land."

5292. Phosphate rock (conglomerate) from Geo. Z. French, Rocky Point.

5293. Phosphatic lime from same locality as 5292.

6942. Phosphate from the land of Hill W. Nixon, Topsail Sound, 3 miles east of Topsail P. O.

PERQUIMANS COUNTY.

2576. Marl from Joseph Moore, New Gardner. Found near Belvidere, 2 to 3 feet below surface. Quantity large.

PITT COUNTY.

1330. Marl from W. H. Cox, Greenville.

1331. Marl from E. A. Johnson, Johnson's Mills.

2883. Blue marl from the land of Wm. and Council Dawson, Scuffleton. Located 15 miles south of Greenville and 1 mile from Contentnea creek. The bed covers about 150 acres and in some places is not more than 3 or 4 feet from the surface. Thickness unknown.

2884. White shell marl from the land of James Dawson, Ridge Springs. Sent by Allen Warren, Greenville, who writes that "the bed is about 75 acres in extent."

2998. Blue marl sent by C. C. Kirkman, of Coxville. The marl is from the farm of A. Williams, 1 mile west of Newbern road and 12 miles south of Greenville. The bed is about 5 acres in extent and is found 6 to 8 feet below the surface.

2999. Blue marl sent by C. C. Kirkman, of Coxville, from the farm of John Branch. The bed is 300 by 200 yards in extent and about 5 feet below the surface. It is located 13 miles south of Greenville, ¼ mile from the Nelson road.

3003. Blue marl, with white shells in it, from the farm of J. G. Shepard, of Farmville. Small amount of lime for marl, but large amount of phosphate.

3119. White shell marl from the farm of G. W. Venters, Calico.

3120. Marl from land of N. H. Hathaway. Sent with No. 3119.

3280. Shell marl sent by Maj. Jos. H. Saunders, of Pactolus, from the farm belonging to Mrs. Wm. Grimes, of Raleigh. The bed is on Bear creek, 6 feet below the surface, and is valuable as a fertilizer, in some cases doubling the yield. Most excellent marl—the per cent. of phosphate and potash being a good one in addition to carbonate of lime.

3554–3556. Blue marl sent by L. B. Burney, of Johnson's Mills, who writes:

"The beds are on Swift creek, 4 miles north of Johnson's Mills. Nos. 3554–3556, which differed in appearance, were taken from the same bed, at depth of 10 feet. The extent of the bed is 2 or 3 acres. No. 3555 was taken from another bed 6 feet deep, extent about 1 acre, thickness unknown." 3554 is a fair marl; 3556 is a very poor one.

4217. White marl from the land of Jas. A. Stokes. Sent by J. M. Dixon, Johnson's Mills.

4219. Marl sent by Maj. R. S. Tucker, Raleigh, from his farm at Pactolus. The bed is situated on Grindel creek and is under the surface on the entire north side of the creek. Is 1 mile north of Pactolus landing on Tar river. The bed is ½ a mile wide and only 2 feet below the surface; thickness unknown.

4220. Marl sent by Maj. R. S. Tucker, from his farm near Pactolus; is 2½ feet below the surface, the land being known as the Robfield. It is found on Tar river, where the high and low river lands meet, and has been found at different places, where excavations have been made, for ½ a mile up and down the river.

4221. Marl from the farm of R. R. Fleming, on Tranter's creek, near the road leading from Pactolus to Washington, and is found in beds similar to the above beds on Major Tucker's farm.

4459. Marl from Senator W. R. Williams, Falkland, who writes: "Came from a hill on my farm, about 1 mile from Tar river, and ½ mile from Otter creek. It has a slightly bluish look but clear."

4527. Marl from T. W. Stokes, Johnson's Mills. "Located on west side of Clay Root swamp flat lands. Extent of bed, as far as been, I suppose 10 or 12 acres. Depth to the marl from 4 to 6 feet. I have been 12 feet down and have never been through."

4943. Marl sent by Allen Warren, Greenville.

5596. Marl from the land of J. H. Clark, near Conetoe. The bed is situated on Conetoe creek; it is about 5 feet from the surface and 9 feet thick.

8047–48. Marls from Fred. F. Brooks, Grifton. "Situated on my land 2 miles northeast of Grifton, at the base of a hill running east and west. The red is from 1 to 3 feet deep, then comes the blue of unknown depth; has been dug 10 feet."

8350. White shell marl from C. C. Kirkman, Redalia, who writes: "There are 8 to 10 acres of it." Sent through W. H. Worth, Raleigh.

ROBESON COUNTY.

1434. Marl from near Lumberton. Sent by Dr. C. W. Dabney, Raleigh.

1740. Marl from E. P. Higby, Lumberton.

3882. White shell marl from J. E. Ashley's farm, 1 mile from Ashpole. "The bed is probably 4 feet thick, 3 feet below the surface, and underlies 1 acre. The bed lies above high water on the banks of a small swamp, and has a great variety of shells and some bones. The marl decomposes very rapidly."

4914. Marl from the farm of A. C. Oliver, Jr., situated on Ashpole swamp, 18 miles south of Lumberton.

SAMPSON COUNTY.

1126. Phosphatic marl from A. S. Colwell, Harrell's Store.

2131. Green sand marl from A. S. Colwell, Harrell's Store.

2383–84. Marls from A. J. Smith, Taylor's bridge. Quantity large.

2423–24. Marls from A. S. Colwell, Harrell's Store.

2534. Marl from W. M. Kellett, Clinton. Found beneath a stratum of shell marl; contained a few bones, etc. Quantity large.

2706. Marl from A. J. Smith, Taylor's Bridge.

3538. Marl from J. R. Harris, Owensville, who writes: "The marl is found in the swamp of Little Coharie creek. It is in veins, and those are from 2 to 4 feet wide and from 6 to 10 inches thick. From the growth I think it covers about ½ acre. It lies on the west side of Little Coharie creek and 12 miles west of Clinton."

6373. Rock marl from the land of T. W. Underwood, Newton Grove.

7881. Marl from the land of R. G. Morrisey, located 4 miles east of Clinton, on the road leading from Clinton to Warsaw. "Very abundant."

2557. Phosphate from farm of W. H. Faison, 6 miles southwest of Warsaw. Found in a ditch 2½ feet below the surface.

2558. Phosphate from the land of Edward Mann, 7 miles southwest of Warsaw.

2559. Phosphate from the land of A. J. Daniel, 7½ miles southwest of Warsaw.

2658. Phosphate from the farm of F. Johnson, 1 mile east of Harrell's store, on Powell creek, 3 feet below surface.

2659. Phosphate from J. F. Taylor's farm, 1 mile east of Harrell's store, on Powell creek, 3 feet below surface.

2660. Phosphate from Lewis Highsmith's farm, 1 mile south of Harrell's store, 3½ feet below surface.

2661. Phosphate from T. N. Fennell's farm, 1 mile south of Harrell's store, on Pharisee creek (a tributary of Doctor's creek), 3½ feet below surface.

2662 *a* and *b*. Specimens of bones from the farm of T. N. Fennell, 1 mile east of Harrell's store, from ditch 2 feet deep.

2663. Phosphate from R. P. Matthis' farm, 3 miles east of Clinton, on plank road, 3½ feet below the surface, on a branch tributary to Six Runs.

2664. Phosphate from W. K. Pigford's farm, 4 miles north of Clinton, 4 feet below surface, on a branch tributary to Six Runs.

2665. Phosphate from L. A. Powell's farm, 10 miles southeast of Clinton, 5 feet below surface in marl bed. Stratum about 6 inches.

2666. Phosphate from Rev. Allen Whitfield's farm, 6 miles north of Clinton. Found 3 feet below surface, in seemingly large quantities, in a stream tributary to Six Runs. Stratum about 6 inches.

2667. Phosphate from J. H. Pugh's farm, 1½ miles north of Clinton, 2½ feet below surface, on a stream tributary to Great Coharie. Stratum about 8 inches. Quantity seems large.

2668. A phosphatic rock from Louis M. Boykin's farm, 8 miles southwest of Clinton, on the Great Coharie, comes with this legend: "Found on the second low grounds in considerable quantities. It is supposed to contain some phosphoric acid and potash, because, as Mr. Boykin says, the crop of corn is always double where this rock underlies the surface. Found on the surface and 1 to 2 feet below." It contains, besides phosphate of lime, a very small amount of potash and soda. Unquestionably this must enrich the soil in contact with it.

The next four specimens were marked "Coprolites," a term which has been used to designate supposed fossil excrements, as distinguished from the common phosphate rock. It is a mistake. They are only worn specimens of the ordinary phosphate of this section.

2669. "Coprolites" from Spencer Merritt's farm, 13 miles southeast of Clinton, 2 feet below the surface. Large quantity.

2670. "Coprolites" from farm of J. D. Carter. 17 miles south of Clinton, in a marl bed 4 feet below surface.

2671. "Coprolites" from farm of J. H. Pugh. Quantity good. Has a glazed surface.

2672. "Coprolites" from farm of L. A. Powell, 10 miles southeast of Clinton, in marl bed 5 feet below surface. Large quantity.

2673. "Coprolites" from farm of D. B. Nicholson, 8 miles southeast of Clinton.

2739. Phosphate rock from J. B. King's farm, 6 miles west of Faison, on Clinton-Goldsboro road, 3 feet below surface, on tributary to Six Runs. Black; very massive. Stratum 8 inches.

2740. Phosphate rock from A. H. King's farm, 11 miles northwest of Faison's, on Faison-Raleigh road, 3 feet below surface in Six Runs. Very massive; quantity seems good. Stratum 8 inches.

2741. Phosphate rock from J. C. Hobbs' farm, 14 miles northwest of Faison's, at Hobbs' Cross Roads. Found in a tributary to Great Coharie, 2 feet below surface. Gray and massive. Stratum 6 inches.

2753. Phosphate rock from farm of F. M. Herring, 15 miles southeast of Clinton. Found just below the surface. Large quantity. Mr. Herring says corn produces a double quantity where this rock exists. On a stream tributary to Six Runs.

2814. Coprolites from farm of John D. Carr, on Black river, about 20 miles southeast of Clinton. Found about 4 feet below surface. Quantity unknown. Found with marl.

STOKES COUNTY.

4023. Limestone from the land of L. H. Hill, Germantown.

4517. Limestone from Dr. W. A. Lash, Walnut Cove, who writes: "This piece of limestone was taken from the lands of the widow of Calvin Morris, 2 miles from the line of the C. F. and Y. V. R. R., and 4 miles west of Walnut Cove."

4518. Limestone from Dr. W. A. Lash, Walnut Cove, who writes: "The piece of limestone was taken from the land of A. H. Morris, on the C. F. and Y. V. R. R., 1 mile east of Germantown."

WAYNE COUNTY.

101 and 122. Marls from deposits near Goldsboro. Sent by J. J. Whitehead, Raleigh.

121. Marl from Dr. B. F. Arrington, Goldsboro.

125–26. Marls taken by Prof. W. C. Kerr from Dr. B. F. Arrington's farm near Goldsboro.

2242. Marl from George C. Moore Goldsboro.

2697. Marl from N. W. Musgrove, Goldsboro.

3407. White shell marl from the farm of Col. J. W. Isler, La Grange, 9 miles northeast of Goldsboro, 3 miles from W. and W. R. R., and underlies 5 to 6 acres.

3159. Blue marl from the farm of J. H. Parks, Goldsboro. The marl is found 4 to 6 feet below the surface, on Bear creek, 7 miles east of Goldsboro and 1 mile east of the A. and N. C. R. R. It has been dug to 25 feet in depth and the bottom not yet reached.

4960–61. Marls from T. B. Parker, Goldsboro.

6614. Lime rock from a deposit near Goldsboro. Taken from the bottom lands where water runs over it. Deposit several acres in extent.

7154. Marl from the lands of Cox & Borden, situated on the N. C. R. R., 9 miles from Goldsboro.

7254. Marl from a deposit on the land of J. P. Cox, Walter, located on the N. C. R. R., 7 miles from Goldsboro.

WILSON COUNTY.

468. Blue marl from F. M. Roundtree, Wilson.

499–500. Marls from James Bryant, Wilson.

671 and 673. Marl from W. P. Carraway, Wilson.

1013. Phosphatic marl from Jesse Mercer, Toisnot.

3096–3098. Yellow earth, supposed to be marl, 4 feet below the surface; 3097, 8 feet below the surface; 3098, white shell marl, 12 feet below the surface.

3099. A mixture of the above three samples, sent by Dr. A. G. Brooks, from the farm of L. F. Lucas, of Lucama. The beds are found on a small branch near Lucama, and the extent is unknown. The beds have been dug to a depth of 20 feet and the bottom is not yet reached.

4203. White shell marl from H. Winstead, Toisnot. The bed is located 3 miles west of Toisnot, on Town creek swamp, near county road leading from Tarboro to Raleigh.

4787. Marl from Dr. A. G. Brooks, Black Creek.

ANALYSES OF MARLS AND PHOSPHATES OF NORTH CAROLINA.

[See Page 472 for Description of Deposits.]

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
	Beaufort Co.					
3287	White shell marl	R. W. Wharton, Washington	1.83	77.16	13.74	trace.
3288	Impure marl	" " "	0.50	82.72	1.54	"
3347	White marl	W. A. Blount, Chocowinity	-----	------	65.86	0.50
4482	Sand marl	F. S. Stickney, Yeatesville	.53	85.39	12.42	------
4524	Marl, top layer	C. F. Warren, Washington	1.54	30.76	62.57	0.10
4525	Marl, second layer	" " "	4.73	80.25	5.73	------
4526	Marl, third layer	" " "	3.66	76.10	12.42	0.25
	Bertie Co.					
2567	Marl	H. V. Dunston, Windsor	1.02	63.71	29.82	small am't.
2568	"	" " "	0.70	11.20	83.10	"
3963	Blue marl	D. Bell, Avoca	----	68.82	19.86	0.50
3964	Yellow marl	" " "	-----	63.04	28.14	1.00
4903	Marl	F. D. Winston, Windsor	0.96	68.15	19.21	0.20
4968	"	" " "	8.21	35.79	63.39	trace.
6481	"	J. H. Brazemore, Lewiston	17.85	65.91	13.90	"
7550	"	W. R. Capehart, Avoca	1.18	56.52	36.48	0.00
7551	"	" " "	0.24	76.24	22.09	0.00
8261	Gray marl	T. B. Davis, Windsor	1.44	62.18	31.39	trace.
8262	Yellow marl	" " "	1.41	65.81	28.42	0.00
	Bladen Co.					
35	Marl	J. G. Blue, Elizabethtown	5.69	41.79	49.50	0.77
2856	White shell rock	R. H. Lyon, "	-----	0.48	94.00	trace.
2857	" " "	" " "	-----	0.65	91.14	"
2858	" " "	" " "	----	1.04	93.93	"
2905	Phosphatic marl	D. A. Lamont, Brinkland	-----	------	large am't.	1.58
3150	Blue marl	W. J. Sutton, Little Sugar Loaf	-----	61.80	32.56	1.00
3151	White shell marl	" " " " "	----	31.53	57.48	3.00
3742	Marl	Dr. J. S. Devane, Brinkland	0.82	65.70	23.26	1.54
3794	Earthy marl	" " " "	-----	50.33	0.00	0.50
4607	Lime rock	L. G. Hall, Elizabethtown	-----	53.12	45.76	------
5618	Marl	E. N. Robeson, Tar Heel	1.32	50.10	44.38	1.09
6173	"	K. J. Brady, Westbrook	-----	30.66	61.14	trace.
6174	"	" " "	-----	38.35	59.33	0.84
6175	"		-----	48.41	48.75	trace.
6389	"	Mrs. E. P. Guion, Lyons Landi'g	-----	75.22	20.61	1.15
6390	Phosphate rock	" " " " "	----	43.72	16.70	36.71
6510	Marl	E. N. Robeson, Tar Heel	-----	58.00	18.72	trace.
6512	"	" " " "	-----	86.98	trace.	"
6511	Fossilized bone	" " " "	-----	------	------	8 to 10
2759*a*	Phosphate rock	Black Rock on Cape Fear river	8.34	33.39	9.05	47.83
2906	Coprolite	D. A. Lamont, Brinkland	-----	------	------	16.56
2907	"	" " "	-----	------	----	14.43
3743	"	Dr. J. S. Devane, Brinkland	-----	43.63	30.38	13.89

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
	Brunswick Co.					
3275	Marl	Henry Addix, New Supply	4.20	63.40	22.88	trace.
	Chowan Co.					
4297	Shell marl	J. M. Hayes, Barnitz	0.24	1.24	95.12	
4485	" "	" " "		1.75	91.89	1.82
	Columbus Co.					
514	Marl	Whiteville Wine Co., Whitev'le		42.14	39.55	trace.
515	"	" " " "		44.00	33.92	
1615	"	Navassa Guano Co., Wilming'n		62.96		5.34
2198	"	J. L. Manning, Peacock's Store		31.87	64.02	
2330	"	Acme Mfg. Co., Wilmington		50.31	45.37	
2331	"	" " " "		36.74	60.40	
3911	"	John Hinson, Chadbourn		54.83	38.62	
6547	" top layer	A. H. Hicks, Whiteville		56.35	30.63	0.30
6548	" second layer	" " "		52.07	37.53	0.30
8260	Shell marl	M. Folly, Aberdeen	0.91	34.87	64.47	0.00
8585	Marl	E. L. Applewhite, Applewhite	0.32	31.92	61.07	0.50
2750	Phosphate nodules	R. D. Sessions, Whiteville	7.72	50.88	0.80	20.44
2754	" "	" " "	0.37	52.15	9.43	32.53
2649	Phosphate	" " "	0.23	51.19	10.91	23.97
2752	Small nodules	Gen. W. G. Lewis, Goldsboro	0.89	10.56	11.66	61.12
3398	Phosphate rock	D. S. Cowan, Robeson		38.99	7.67	25.12
	Craven Co.					
278	Limestone	R. A. Russell, Cobton	12.66	6.68	68.42	
428	Marl	Jno. A. Jackson, Vanceboro		29.62	59.02	
506	"	Chas. B. Stubbs, "		74.95	12.13	
523	Earth	Henry Powell, "		15.48		
644	Marl	O. C. Noble, "	1.94	88.55	3.00	
659	"	C. E. Mallett, Riverdale	0.94	77.02	16.55	
721	"	Geo. Allen, Newbern	16.66	40.06	12.38	trace.
1119	"	L. Harvey, Kinston	19.87		71.76	
1139	"	Geo. Green, Jr., Newbern		60.14	35.00	0.53
1297	"	Geo. Allen & Co., "		43.01	49.50	
1952	"	J. Y. Brice, Charlotte		31.17	62.14	0.50
2153	" top stratum	D. Reid, Newbern		50.06	37.78	
2154	" 2d stratum	" "		54.05	44.78	
2155	" top stratum	" "		16.76	80.21	
2156	" 2d stratum	" "		29.79	64.35	1.09
2157	" 3d stratum	" "		11.54	84.54	1.09
2855	White shell marl	K. R, Jones, Newbern		8.13	90.18	trace.
2859	White marl	Geo. Allen & Co., Newbern		93.52	2.50	
2860	White marl	" " " "		23.20	64.38	trace.
3241	Blue marl	J. Y. Brice, Charlotte		74.30	15.21	2.73
4504	Marl	N. A. Pursser, Vanceboro	9.15	38.88	48.20	0.20
3767	Yellow marl	L. J. Moore, Newbern	0.06	25.75	68.30	2.00
4033	White marl	J. A. Jackson, Vanceboro		8.29	89.28	0.50
4204	Yellow marl	J. Y. Brice, Charlotte		55.25	36.71	1.00
4652	Marl	G. V. Chapman, Maple Cypress	13.85	29.95	50.13	trace.
6334	"	Wm. B. Lane, Newbern		33.78	60.12	0.31
6414	"	Watson & Daniels, Newbern			12.65	0.54
6506	"	J. B. Gardner, Maple Cypress		35.29	45.90	small am't.
6507	"	J. B. Gardner, Maple Cypress		19.17	72.78	trace.
6508	"	" " " "		24.79	67.32	small am't.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
6523	Marl	Watson & Daniels, Newbern	-----	8.73	87.16	trace.
6524	"	" " " "	-----	16.80	78.19	trace.
6526	"	" " " "	-----	5.63	90.98	0.50
6527	"	" " " "	----	7.23	88.25	0.25
6528	"	" " " "	-----	16.17	79.00	trace.
8253	"	Andrew Jackson, Vanceboro	2.36	77.84	10.62	trace.
8349†	Calcined marl	G. L. Hardison, Thurman	3.59	69.18	14.22	abt.25
8351	Black marl	W. H. Worth, Raleigh	3.42	73.30	16.33	2.00
	Cumberland Co.					
1116	Blue marl	E. J. Fuller, Fayetteville	13.74	67.18	12.26	0.53
1117	Shell marl	" " "	-----	39.76	55.35	0.47
	Duplin Co.					
456	Marl	W. H. Williams, Warsaw	-----	82.17	2.96	------
457	"	" " "	----	47.67	35.50	------
458	Shell marl	" " "	-----	50.52	31.07	------
972	Marl	R. J. Williams, "	-----	25.07	63.03	2.35
1127	"	Mord Taylor, Magnolia	-----	19.47	72.80	trace.
1183	"	J. R. Faison, Faison	-----	59.92	38.00	------
2120	"	Levi Moore, Warsaw	-----	18.81	40.08	1.22
2835	"	J. C. Maxwell, Resaca	----	68.12	14.84	small am't.
2836	"	" " "	-----	90.83	1.98	"
3197	White shell marl	E. J. Hill, Warsaw	-----	51.97	43.27	5.45
3865	White marl	Dr. Matt Moore, Warsaw	-----	------	85.91	------
4321	White shell marl	B. Whitherington, Faison	1.07	14.55	81.25	0.50
4364	Blue marl	" " "	1.27	80.58	8.26	0.25
4365	White marl	" " "	1.48	20.63	74.49	0.25
4373	" "	W. B. Southerland, Rose Hill	0.63	15.41	76.38	0.25
4424	" "	T. S. Kenan, Raleigh	1.10	18.37	71.15	0.95
4425	Green "	" " "	3.70	69.94	1.14	4.69
4165	White "	W. L. Hill, Warsaw	1.30	17.49	72.66	0.50
4675	Marl	Jno. O'Bryne, Kenansville	17.10	70.69	70.60	trace.
5246	"	A. W. Maxwell, Resaca	-----	10.21	83.38	"
5594	Phosphatic marl	G. W. Lamb, Chinquepin	7.03	14.21	74.24	2.74
5595	Marl	" " "	28.04	62.58	2.91	1.65
5647	"	W. B. Southerland, Rose Hill	0.66	7.01	90.74	------
6146	Phosphatic marl	Daniel Moore, Warsaw	3.13	83.42	------	6.71
6166	" "	" " "	-----	70.96	1.70	17.18
6435	Marl	A. D. McGowan, Kenansville	2.32	23.40	68.59	trace.
6465	Green marl	Milton Southerland, Wallace	2.74	87.24	1.46	"
6487	Phosphatic marl	" " "	4.37	74.90	2.30	5.09
6493	" "	Daniel Moore, Warsaw	-----	-----	0.82	9.97
6644	Gray marl	D. McL. Graham, Wallace	-----	63.92	22.77	1.65
6645	Blue marl	" " " "	-----	83.20	10.64	1.00
2263	Phosphate	Levi Moore, Warsaw	-----	41.06	4.86	44.03
2334	"	R. M. Middleton, Warsaw	3.75	45.62	4.59	39.86
2335	"	R. M. Middleton, "	2.39	44.73	2.30	39.33
2336	"	R. M. Middleton, "	3.26	49.58	4.98	38.33
2337	"	G. W. Middleton, "	1.79	51.17	5.91	37.28
2338	"	R. M. Middleton, "	0.59	52.00	7.72	32.59
2339	"	A. M. Faison, Raleigh	3.54	47.74	7.96	39.03
2490	"	J. W. Best, Warsaw	1.08	42.96	4.18	42.46
2541	"	W. H. Kornegay, Kenansville	0.86	38.80	4.65	43.94
2580	"	J. W. Best, Warsaw "	0.52	------	7.77	39.97
2488	"	Daniel Bowden, Bowden's	0.41	50.02	4.72	33.32

† Contains lime as oxide, 2.09 per cent.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
2489	Phosphate	Arthur Weeks, Bowden's	0.40	39.71	4.48	43.29
2474*a*	"	J. W. Murray, Kenansville	.....	42.43	9.45	37.98
2474*b*	"	" " "	.....	59.82	5.25	28.18
2491	"	A. M. Faison, Warsaw	0.56	58.38	2.95	32.67
2492	"	Rufus Bowden, "	0.60	60.58	3.43	28.88
2542	"	G. W. Middleton, Warsaw	1.73	59.47	3.12	28.16
2543*a*	"	R. Middleton, Warsaw	1.57	28.09	3.81	45.16
2543*b*	"	" " "	0.92	28.92	2.43	57.18
2544	"	Jesse Swinson "	0.51	64.97	2.85	23.24
2545	"	J. A. Boyd, "	1.58	48.57	2.95	37.72
2546	"	Kilby Hollingsworth, Magnolia	1.78	40.92	3.56	46.13
2547	"	L. Middleton, Warsaw	1.06	29.46	3.90	54.89
2548	"	A. Hollingsworth, Magnolia	0.41	45.20	4.18	40.09
2549	"	Levi Moore, Warsaw	0.63	37.36	4.96	44.51
2550	Coprolites	R. Middleton, "	1.56	38.82	3.35	46.06
2551	Phosphate	" " "	0.89	33.42	3.02	41.94
2552	"	A. D. Johnson, Kenansville	0.48	58.54	3.41	29.85
2553	"	G. W. McClammy, "	0.53	37.75	4.30	45.29
2554	Fragments of bone, coprolites, rock	J. B. Carr, Kenansville	1.65	3.55	3.94	73.38
2555	Coprolites	A. D. Johnson, "	0.79	20.93	3.83	64.62
2556	Phosphate	A. M. Faison, Warsaw	1.08	39.60	3.01	46.56
2560	"	J. N. Williams, "	0.80	43.11	4.54	42.20
2561	"	A. M. Faison, "	0.58	41.12	3.59	45.05
2562	"	W. C. Carlton, "	1.06	48.13	3.17	39.40
2563	"	W. H. Windows, "	0.23	42.06	3.65	45.16
2564	"	" " "	1.50	48.32	3.50	37.95
2565	"	" " "	0.80	52.52	2.84	31.45
2566	"	" " "	6.10	63.85	1.81	23.05
2632	"	J. R. West, "	0.73	47.26	5.09	35.67
2633	"	Thos. V. Turrence "	0.35	62.91	4.18	25.41
2634	"	A. West, Warsaw	0.73	25.73	7.50	53.75
2635	"	Jesse Swinson, Bowden's	1.51	38.92	5.16	43.29
2636	"	R. W. Boyette, "	0.59	45.72	5.39	38.90
2639	"	L. Aaron, Warsaw	0.55	51.63	4.45	36.70
2648	"	Henry Best, "	0.65	45.92	4.93	39.32
2650	"	J. F. Croom, Magnolia	0.49	49.93	6.52	35.98
2651	"	M. West, "	0.38	44.37	6.50	36.84
2653	"	J. S. Taylor, "	0.98	37.47	6.91	31.67
2654	"	J. R. Wells, "	0.93	46.86	3.64	32.99
2655	"	S. Boone (col.) "	0.97	37.60	5.07	32.64
2656	"	A. S. Colwell "	0.73	59.24	3.11	31.13
2742	"	Alonzo Rich, Faison's	0.86	34.60	5.71	46.19
2743	"	L. T. Hicks, "	0.66	35.76	5.11	43.53
2745	Black rock	C. C. Ricks, "	0.49	43.81	5.36	24.93
2746*a*	Phosphate, white, compact	Lovette J. Lee "	2.07	1.49	12.00	71.82
2746*b*	Phosphate, gray, compact	" " "	2.50	0.05	8.98	76.82
2746*c*	Phosphate, white, gritty	" " "	0.77	32.79	1.45	7.42
2746*d*	Phosphate, gray	" " "	2.70	0.64	7.07	76.54
2746*e*	Phosphate, common black	" " "	0.81	45.91	5.84	36.02
2747	Phosphate	Mrs. M. E. Pass, "	1.05	43.90	5.52	39.99
2749	"	I. R. Faison, "	0.39	58.53	4.09	27.88

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2751	Phosphate	W. G. Lewis, Goldsboro	0.80	15.27	16.71	53.22
2757*a*	Phosphatic marl	" " "	0.34	29.49	52.14	9.98
2757*b*	" "	" " "		15.27	16.71	53.22
2801	" "	Spiers Lanier, Kenansville	1.07	36.98	16.07	24.67
2802	Phosphate	John Castine, "	0.73	41.24	4.93	42.79
2803*a*	Phosphate rock	Robert James, "	0.38	42.17	46.69	2.91
2803*b*	" "	" " "		6.33	64.46	19.23
2804	" "	" " "	0.34	22.41	59.55	10.50
2805	" "	" " "	0.33	40.66	53.94	1.79
2806	" "	D. J. Middleton, Warsaw	1.48	61.66	2.89	29.12
2807	" "	" " "	0.97	43.21	4.54	44.29
2808	" "	J. B. Pearce, "	1.00	35.10	7.48	45.12
2809	" "	D I. Woodward, "	0.66	30.44	6.30	53.03
2810	" "	" " "	0.39	36.59	6.30	45.78
2811	" "	J. W. Best, "	0.42	23.95	2.04	20.54
2812	Phosphatic marl	Wm. A. Faison, "	0.49	46.40	5.25	36.08
2815	Phosphate rock	Wm. Boyette, "	0.90	54.75	3.30	32.55
2816	Blue marl	Ransom Middleton, "	0.65	81.59	1.55	9.89
2817	White shell marl	" " "	0.29	46.92	37.78	8.58
2821	Phosphate rock	John Fredricks, "	0.28	68.06	3.64	23.03
2822	" "	W. H. Sloan, Chinquepin	0.36	45.16	4.57	trace.
3100	" "	John Fredricks, Warsaw	0.27	44.48	6.56	38.40
4423	" "	Stephen Graham, Kenansville	0.23	63.16	3.80	25.54
	Edgecombe Co.					
34	Marl	K. P. Battle, Chapel Hill	24.00			1.48
474	"	J. R. Thigpen, Tarboro	3.90	47.80	21.44	0.21
502	Shell marl	Jesse Mercer, "	1.48	72.96	16.24	2.85
513	" "	J. R. Thigpen, "	0.66	14.73	62.80	0.78
626	Marl	" " "	6.73	46.61	12.60	
627	"	" " "	4.52	56.22	26.70	2.43
628	"	" " "	0.61	24.14	51.48	2.88
629	"	" " "	0.66	37.33	35.45	1.26
660	"	John S. Dancy, "	2.32	81.41	trace.	
984	"	J. R. Thigpen, "		60.82	15.00	1.35
1205	Black marl	" " "		71.78	21.67	0.64
1206	Yellow marl	" " "		36.98	56.02	0.46
1619	Marl	" " "			20.24	
2618	Yellow marl	J. Lancaster, "		32.32	67.87	1.59
2865	Marl	M. Battle, "			trace	0.76
3075	White shell marl	T. W. Battle, Rocky Mount	9.95	74.86	10.57	trace.
3076	Blue marl	" " " "	11.93	81.59	1.78	"
3154	White shell marl	" " " "	3.87	72.85	16.64	"
3468	Blue marl	" " " "	1.01	84.98	9.13	2.96
3539	Clayey marl	E. V. Zoeller, Tarboro	4.88	72.24	12.67	3.46
3540	White shell marl	" " "	7.32	71.97	14.32	1.96
3541	" " "	" " "	1.39	83.97	5.35	4.14
3542	" " "	" " "	1.78	79.88	8.57	4.27
4181	" " "	W. R. Cox, Raleigh	1.74	49.91	41.25	2.29
4222	Marl, earthy	C. H. Blocker, Tarboro	2.50	85.91	1.82	0.50
4223	White shell marl	" " "	6.06	84.46	8.07	0.50
4224	Shell conglom'rate	" " "	0.64	47.73	47.17	1.70
4225	White shell marl	E. B. Hodges, "	0.39	42.46	52.43	3.94
4226	Earthy marl	" " "	9.97	77.10	5.11	1.82
4284	Marl, white powd'r	J. M. Mayo, Whitakers	0.80	2.98	94.19	
4394	Yellow marl	C. H. King, Tarboro	0.93	34.04	59.48	0.25
4460	Marl	E. B. Hodges, "	0.35	45.68	49.81	2.82

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4461	Marl	E. B. Hodges, Tarboro	0.56	68.18	23.08	3.27
4486	Gray marl, top lay'r	A. B. Nobles, "	1.89	54.71	8.23	22.32
4487	Black marl, second layer	" " "	11.47	70.96	2.75	4.44
4488	Shell marl, third layer	" " "	2.70	37.41	39.01	11.34
4489	Marl, fourth layer	" " "	1.30	55.98	27.59	7.52
4522	Marl	T. H. Battle, Rocky Mount	0.42	2.86	93.42	------
4966	Marl, No. 1	G. A. Stancil, " "	7.01	54.94	38.05	------
4967	Marl, below No. 1	" " " "	58.05	.80	22.04	19.11
5527	Marl	Robert Pitt, St. Lewis	1.12	63.80	27.29	2.99
5528	"	" " " "	0.78	33.18	57.65	2.74
6151	"	Fred. Phillips, Tarboro	1.34	78.60	5.02	1.65
6273	"	E. L. Pitt, St. Lewis	-----	59.73	29.87	3.02
6274	"	" " " "	-----	65.80	25.30	2.88
6303	"	R. E. Pitt, " "	-----	59.84	30.96	2.93
6304	"	" " " "	-----	45.90	46.20	2.21
6554	"	D. H. Barlow, Rocky Mount	-----	56.94	30.70	2 75
3279	Phosphate	A. B. Nobles, Tarboro	1.31	43.32	14.55	21.52
3772	Phosphate, brown rock	" " "	-----	82.69	0.00	7.54
3773	Phosphate, gray rock	" " "	-----	80.76	0.00	9.11
3774	White rock	" " "	-----	62.82	1.22	25.43
	Franklin Co.					
4908	Marl	C. O. Durant, Youngsville	-----	57.52	33.21	0.53
4909	"	" " "	2.86	12.98	84.16	------
	Greene Co.					
257	Marl	Ben. S. Hardy, Hookerton	2.00	37.36	59.40	0.39
258	"	John Sullivan, Snow Hill	2.50	47.10	41.80	2.86
2320	" light color	Levi H. Mewborne, " "	2.87	94.87	4.02	0.76
2321	" gray	" " " "	4.82	88.29	2.41	1.81
2322	Dark green marl	" " " "	0.37	60.98	4.73	24.82
2577	Marl (near surface)	" " " "	-----	64.13	2.18	28.58
4285	White shell marl	E. C. Blount, Willow Green	2.92	56.66	25.27	3.91
4359	Blue marl	Jno. P. Gray, Snow Hill	4.29	59.74	.25	19.84
4938	Marl	" " " " "	59.47	32.78	7.75	trace.
5717	"	B. T. Mooring, Jason	4.62	80.88	2.59	3.80
	Halifax Co.					
2571	Marl	R. H. Smith, Scotland Neck	-----	48.94	8.03	4.95
2572	"	" " " "	-----	50.79	36.09	small am't.
2573	"	" " " "	-----	77.48	16.10	"
2574	"	" " " "	-----	89.39	0.64	"
2575	"	" " " "	-----	44.19	43.34	4.21
2765	"	J. R. Tillery, Tillery	0.39	8.13	81.01	small am't.
3355	White shell marl	Wm. E. Fenner, Halifax	12.80	30.90	39.39	3.49
3403	Blue marl	H. B. Moore, Palmyra	-----	52.22	32.84	1.00
4413	" "	Ashley Wilkins, South Gaston	-----	71.72	10.12	3.24
3763	White shell marl	E. T. Branch, Enfield	0.75	39.29	51.52	1.00
3764	Shell marl	John S. Gregory, Halifax	1.03	52.20	32.37	3.60
	Hertford Co.					
2211	Marl	Tyrone Spiers, Como	-----	65.82	23.35	------
3696	Shell marl	T. H. Debnam, Winton	-----	65.53	8.02	0.50
6408	Marl	John Brewer, Murfreesboro	-----	------	40.96	trace.

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6409	Marl	John Brewer, Murfreesboro	.....	.....	33.53	0.54
6410	"	" " "	.....	.....	36.92	0.54
6456	"	J. M. Wynn, "	0.69	26.27	61.66	0.45
6457	"	" " "	2.22	45.32	46.58	0.42
8235	"	J. C. Drake, Lotta	.....	.....	33.60	trace.
	Johnson Co.					
2937	White marl	H. N. Bizzle, Glenwood	.....	38.85	54.41	trace.
	Jones Co.					
259	Marl	H. C. Koonce, Comfort	0.92	4.80	88.70	trace.
260	Phosphatic marl	C. J. Mattock, Pollocksville	0.83	25.90	66.40	4.33
261	" "	" " "	0.73	25.50	65.40	3.63
262	Marl	Frank Foy, Pollocksville	0.60	29.60	61.40	2.79
654	"	A. T. Uzzell, Tuckahoe	1.75	26.33	61.81	.....
653	"	" " "	1.21	54.09	38.55	.....
2425	Phosphatic marl	A. P. Barrow, Pollocksville	0.77	46.36	39.94	5.61
2426	Marl	" " "	0.50	20.34	71.08	small am't.
2584	"	W. A. J. Pollock, Kinston	.....	.....	.....	trace.
2585	"	" " "	.....	14.18	79.83	small am't.
2586	"	" " "	.....	39.90	54.19	"
2587	"	" " "	.....	27.78	60.71	"
2588	"	" " "	.....	2.76	98.06	"
4468	Blue marl	L. Harvey, "	3.50	25.71	71.76	0.50
4618	Marl	W. M. Jones, Cary	.....	63.76	32.21	2.18
6405	"	C. H. Foy, Kinston	.....	.....	88.25	3.27
6406	"	" " "	.....	.....	4.98	0.54
3101	Phos. nodules	W. G. Lewis, Goldsboro	0.64	7.09	18.42	47.50
	Lenoir Co.					
433	Shell marl	S. E. Hodges, Falling Creek	.....	44.81	45.08	.....
434	" "	" " " "	.....	69.69	18.47	.....
435	Clay marl	" " " "	.....	57.27	32.07	.....
436	Shell marl	Noah Rouse, La Grange	.....	12.52	74.05	.....
437	" "	" " "	.....	17.51	58.32	.....
438	Clay "	B. F. Herring "	.....	84.27	0.43	.....
440	Shell marl	Thomas Dawson, "	.....	25.32	62.87	.....
645	Marl	S. J. Sutton, "	0.81	39.51	52.52	.....
658	Marl	" " "	1.33	48.97	42.02	.....
1340	Ground oyster shells	L. Harvey, Kinston	.....	.....	88.05	trace.
1637	Phosphatic marl	E. S. Broadway, Kinston	0.88	78.20	14.90	3.20
1645	Marl	E. Grady, Kinston	0.69	10.80	83.90	0.91
2162	"	Seth West "	.....	25.84	59.93	1.09
2209	Phosphate	H. O. Hyatt, "	.....	.....	.....	40.67
2427	Marl	W. G. Lewis, Kinston	0.40	9.34	87.67	.....
2428	"	" " "	0.51	8.84	89.06	.....
2429	"	" " "	0.36	8.38	89.10	.....
2430	"	" " "	1.08	41.76	52.03	.....
2431	"	" " "	0.49	44.37	51.87	.....
2432	"	" " "	3.90	82.59	1.89	3.72
2433	"	" " "	0.25	44.06	55.14	2.01
2434	"	" " "	3.81	84.18	3.43	3.65
2435	"	" " "	2.61	80.25	8.41	0.74
2478	"	W. B. Nunn, "	1.59	93.10	0.39	.....
2953	"	G. E. Miller, "	.....	49.75	43.83	very small.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
3189	Ground shell	Harvey & White, Kinston	-----	------	73.85	0.05
3245	White shell marl	L. J. Moore, "	0.40	5.81	87.64	trace.
4467	White marl	L. Harvey, "	1.43	89.10	5.44	------
3658	White shell conglomerate	H. O. Hyatt, "	0.08	36.25	59.14	2.10
4741	Marl	A. B. Nobles, "	-----	------	48.58	1.48
4837	Marl bed clay	A. J. Kilpatrick, "	-----	87.59	.18	2.99
4838	Gray marl	" " "	-----	45.84	33.00	2.79
4839	Shell and sand	" " "	-----	51.69	27.06	5.25
4840	Green sand	" " "	-----	76.36	1.48	5.87
5370	Rock	" " "	-----	----	81.50	0.70
6041	"	B. F. Sutton, La Grange	15.81	72.48	5.25	1.87
6162	"	J. M. Kilpatrick, La Grange	-----	------	24.21	1.42
6837	"	P. H. Mewborn, Kinston	2.59	80.52	5.85	trace.
	Martin Co.					
2277	Marl	Wm. Slade, Williamston	-----	62.64	28.21	------
2286	Shell marl	N. S. Peal, "	-----	70.33	23.21	------
2885	Marl	Amos Robinson, Everett's	-----	61.20	27.95	trace.
2886	Rock marl	" " "	-----	48.61	21.95	trace.
	Montgomery Co.					
8733	Marl	J. W. Thompson, Raleigh	0.72	13.53	80.70	trace.
	Nash Co.					
681	Marl	T. P. Braswell, Battleboro	23.61	64.59	7.74	------
2625	Ground marl	J. H. Ennis, Raleigh	-----	49.20	42.39	1.83
3587	White marl	W. E. Philips, Battleboro	-----	66.18	22.69	1.96
	New Hanover Co.					
410	Blue marl	Cronly & Morris, Wilmington	-----	67.42	23.76	0.39
411	Stone marl	" " "	----	45.34	52.28	0.73
412	Blue marl	" " "	----	34.22	------	51.89
413	Shell conglomerate	" " "	-----	14.92	------	59.37
507	Marl	" " "	-----	74.77	10.00	------
508	Blue marl	" " "	-----	66.50	21.13	1.15
509	Phosphatic rock	" " "	-----	48.12	35.11	7.04
510	" "	" " "	-----	42.82	48.39	10.96
511	" "	" " "	----	18.32	74.53	6.90
879	Blue marl	Fred. D. Thorn, "	0.52	24.23	69.17	------
1289	Marl	W. C. Kerr, Raleigh	-----	71.26	18.08	0.78
1981	Nodule	T. D. Hogg, Raleigh	0.85	22.07	42.12	20.50
1982	Conglomerate	" "	0.49	33.52	20.45	33.97
1983	"	" "	-----	3.04	90.70	1.46
1994	"	" "	-----	----	------	13.40
2029	Nodule	" "	0.41	43.66	34.55	19.99
2100	"	S. W. Noble, Wilmington	0.40	3.25	51.34	31.59
2101	Conglomerate	" "	0.39	16.59	67.47	4.15
2102	Nodules	" "	2.00	31.66	15.94	42.09
2103	Conglomerate	" "	8.54	42.48	10.12	26.64
2104	"	" "	0.61	35.48	51.81	6.40
2132	Nodules (mixture)	T. D. Hogg, Raleigh	-----	------	------	30.90
2231	Burned rock	" "	-----	32.29	------	15.11
2250	Phosphate	" "	-----	16.76	------	6.89
2251	"	" "	-----	36.53	------	20.04
2333	Ground conglomerate	" "	-----	23.37	64.26	11.16
2344	Coarse nodules left on sieve, burned	" "	-----	31.08	*32.69	28.90

*Lime as ox carbonate combined.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
2345	Sifted from conglomerate burn'd	T. D. Hogg, Raleigh	-----	22.49	*46.16	6.76
2422	Phosphatic marl	Cronly & Morris, Wilmington	-----	22.74	16.14	6.17
3187	Conglomerate	C. M. Hawkins, Raleigh	6.56	15.66	63.02	14.02
3261	Phosphate	P. H. Andrews, "	0.56	22.31	------	38.16
3417	"	P. M. Wilson, "	-----	------	------	17.15
3418	"	" "	-----	------	------	19.61
3536	Ground rock	Bernardt & Co., Pioneer Mills	0.57	18.44	65.77	11.73
3548	Phosphate	C. M. Hawkins, Raleigh	0.65	29.09	22.28	39.79
2775	Ground phosphate	N. C. Phos. Co., "	0.28	------	------	11.09
3795	" "	T. Ivey, Ashpole	0.98	18.47	56.60	13.69
3854	" "	T. D. Hogg, Raleigh	----	------	------	10.42
3926	Blue marl	" "	-----	44.03	50.05	1.00
3930	Phosphate nodules	N. C. Phosphate Co., Raleigh	0.80	35.05	38.92	13.50
4234	Phosphate	C. M. Hawkins, Raleigh	-----	43.38	------	13.10
4235	"	" " "	-----	54.52	------	1.79
4594	"	Marmaduke Hawkins, Raleigh	-----	------	59.34	19.36
4595	"	" " "	-----	------	16.17	64.65
4604	Ground phosphate	P. M. Wilson, Raleigh	-----	------	61.03	9.42
4605	" "	" " "	-----	------	76.74	6.71
4606	" "	" " "	-----	------	78.15	6.31
4884	Nodules, finest	" " "	-----	------	13.01	10.25
4885	" medium	" " "	-----	------	8.44	43.17
4886	" coarser	" " "	-----	------	8.76	37.19
4933	Ground phos., fine	" " "	-----	------	------	37.83
4934	" coarse	" " "	-----	------	------	33.81
5714	Phosphate	C. M. Hawkins, "	----	68.54	0.00	11.87
6153	Marl	H. W. Malloy, Wilmington	2.26	25.36	56.39	0.67
	Northampton Co.					
3290	Blue marl	J. E. Stancil, Margarettsville	2.05	87.13	3.14	trace.
8718	Marl	W. J. Edwards, Severn	3.88	45.63	33.67	0.20
	Onslow Co.					
2494	Phosphate rock	David Sandlin, Richlands	-----	12.27	60.62	12.24
2495*a*	Coprolites, white	J. M. F. Brock, "	-----	53.91	4.57	31.50
2495*b*	" dark	" "	-----	4.95	88.94	2.30
2496	"	L. Franks, "	-----	25.36	9.77	50.60
2590	Phosphate	Geo. Allen & Co., Newbern	3.04	1.35	7.73	74.03
2818	Marl	A. H. Rodes, Tar Landing	0.40	47.86	4.48	37.79
2819	"	Allen Murrill, "	0.58	42.25	6.20	37.22
2820	Phosphate rock	Chris. Stevens, Jacksonville	0.29	44.64	7.91	35.78
2832	Yellow marl	Geo. Allen & Co., Newbern	-----	8.13	81.01	s.amt.
2833	Grav marl	" " "	-----	2.96	92.60	------
4233	Yellow marl	J. L. Nicholson, Richlands	-----	56.96	0.68	5.67
6464	Shell marl	Geo. R. Venters, Green Branch	0.48	50.62	42.28	4.61
6942	Phosphate	H. W. Nixon, Jacksonville	-----	------	------	13.05
8623	Marl	H. D. Murrill, Jacksonville	0.36	26.79	66.49	1.15
	Pasquotank Co.					
4821	Marl	R. B. Creecy, Elizabeth City	9.84	62.27	26.89	1.00
	Pender Co.					
1278	Limestone	French Bros., Rocky Point	-----	------	87.64	------
1279	Limestone	" "	-----	------	92.58	------
2221	Marl	Nicanor Powers, S. Washing'n	21.50	66.08	9.39	------
3747	Marl	" "	-----	------	44.71	1.00
2097	Nodules	French Bros., Rocky Point	0.86	18.50	39.04	25.34
2098	"	" "	1.33	20.02	42.12	22.68
2099	Conglomerate	" "	0.51	20.28	57.29	11.81

*Lime as oxide and carbonate.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
2109	Nodules	French Bros., Rocky Point	-----	-----	-----	13.73
2130	Nodules	" "	-----	-----	-----	19.62
2222	Conglomerate	" "	-----	24.96	54.71	16.42
2223	No. 2222 after burning	" "	-----	36.49	*37.52	20.34
2250	Conglomer. burn'd and sifted	" "	-----	16.76	*60.00	6.89
2251	Nodules from No. 2250	" "	-----	36.53	*38.36	20.04
2267	Phosphate	Geo. Z. French, "	-----	-----	-----	11.76
2268	"	" "	-----	-----	-----	41.24
2657	"	J. Alderman, Duplin Road	-----	56.95	6.70	29.36
2757	Phosphate rock	C. P. Moore, Point Caswell	0.32	61.96	4.32	21.02
2758	Nodules	C. P. Moore, "	0.42	24.77	15.55	47.50
3239	Phosphate rock	W. G. Lewis, Goldsboro	1.18	22.75	16.06	43.72
3526	Coprolite	French Bros., Rocky Point	0.41	18.26	57.95	11.09
3753	Phosphate rock	" "	-----	-----	-----	4.36
3865	White marl	Dr. Matt. Moore, Warsaw	-----	-----	85.51	-----
4429	Phosphate rock	G. Z. French, Rocky Point	-----	-----	-----	49.48
4430	" "	" "	-----	-----	-----	54.76
4536	Phosphate rock	N. W. Powers, S. Washington	-----	51.46	-----	10.06
5292	Phos. conglomerat'	Geo. Z. French, Rocky Point	-----	-----	63.09	9.95
5293	Phosphatic lime	" "	-----	-----	†11.33	7.74
6942	Phosphate	Hill W. Nixon, Topsail	-----	-----	-----	13.05
	Perquimans Co.					
2576	Marl	Joseph Moore, New Gardner	----	36.66	52.87	-----
	Pitt Co.					
1330	Marl	W. H. Cox, Greenville	-----	-----	68.06	-----
1331	"	E. A. Johnson, Johnson's Mills	1.26	28.50	63.86	0.30
2883	Blue marl	Allen Warren, Greenville	-----	15.81	77.54	trace.
2884	White shell marl	" "	-----	59.41	35.77	"
2998	Blue marl	C. C. Kirkman, Coxville	-----	81.10	10.21	"
2999	"	" "	-----	89.09	5.93	"
3003	Blue with white shell marl	J. G. Shephard, Farmville	----	73.91	13.99	6.01
3119	While shell marl	G. W. Venters, Calico	-----	16.41	74.61	small am't.
3120	Marl	" "	-----	30.71	53.30	trace.
3280	Shell marl	Jos. H. Saunders, Pactolus	1.12	44.20	42.73	6.47
3554	Blue marl	L. B. Burney, Johnson's Mills	----	52.41	40.73	1.84
3555	"	" "	-----	87.09	2.35	1.54
3556	"	" "	-----	78.61	12.99	0.78
4217	White marl	Joe M. Dixon, Johnson's Mills	-----	35.71	27.14	0.80
4219	Shell marl	R. S. Tucker, Raleigh	-----	62.72	26.75	4.00
4220	"	" "	-----	65.64	12.57	8.00
4221	"	" "	-----	69.49	14.67	2.00
4278	White marl	J. W. Quinerly, Johnson's Mills	1.09	41.45	51.13	0.25
4459	Marl	W. R. Williams, Falkland	1.80	83.00	6.91	1.09
4527	Marl	T. W. Stokes, Johnson's Mills	10.44	28.11	53.70	0.50
4943	Marl	Allen Warren, Greenville	15.30	47.41	37.29	trace.
5596	Phosphatic marl	W. B. Dawson, Conetoe	1.92	59.77	23.52	4.22
8047	Blue marl	Fred F. Brooks, Grifton	1.65	-----	13.24	trace.
8148	Red marl	" "	0.70	-----	47.90	6.00
8350	White shell marl	W. H. Worth, Raleigh	0.64	8.91	85.46	1.00

* Lime as oxide and carbonate combined. † Lime as oxide and hydrate=46.65

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
	Robeson Co.					
1434	Marl	C. W. Dabney, Raleigh	1.06	54.75	35.03	trace.
1740	Marl	E. P. Higby, Lumberton	-----	63.40	21.01	------
3882	White shell marl	T. Ivey, Ashpole	-----	51.86	41.78	2.00
4914	Marl	A. C. Oliver, Fair Bluff	-----	34.42	60.14	2.93
	Sampson Co.					
1126	Phosphatic marl	A. S. Colwell, Harrell's Store	----	74.58	5.87	*12.16
2131	Green sand	A. S. Colwell, Harrell's Store	-----	92.19	1.20	0.91
2383	Marl	A. J. Smith, Taylor's Bridge	-----	59.73	26.64	1.50
2384	"	" "	----	33.71	56.17	0.75
2423	"	A. S. Colwell, Harrell's Store	1.85	72.71	8.82	3.93
2424	"	" "	0.40	16.95	75.69	------
2534	Phosphatic marl	W. M. Killett, Clinton	0.80	85.23	1.45	7.31
2706	Marl	A. J. Smith, Taylor's Bridge	--- .	52.60	41.87	trace.
3538	"	J. R. Harris, Owensville	7.32	72.99	4.64	0.64
6373	Marl rock	T. W. Underwood, Newton Grove	-----	35.42	55.86	0.78
7881	Marl	R. G. Morrisey, Clinton	----	------	40.99	0.50
2557	Phosphate	W. H. Faison, Warsaw	0.58	30.47	4.84	49.47
2558	"	Edward Mann, "	0.46	52.00	3.93	33.60
2559	"	A. J. Daniels, "	0.34	42.79	4.20	42.00
2658	"	F. Johnson, Harrell's Store	0.42	47.18	5.91	28.09
2659	"	J. F. Taylor, "	0.33	47.41	5.27	38.31
2660	"	Lewis Highsmith, "	0.22	70.78	4.20	20.24
2661	"	T. N. Fennel, "	0.55	54.96	3.91	32.05
2662*a*	Fossil bone	" "	2.62	1.58	9.55	69.55
2662*b*	Phosphate rock	" "	0.46	51.75	4.52	32.53
2663	Phosphate	R. P. Matthis, Clinton	0.34	49.34	4.66	33.62
2664	"	W. K. Pigfords, "	1.19	29.41	5.68	38.09
2665	"	L. A. Powell, "	0.39	51.93	6.43	29.93
2666	"	Allen Whitfield, "	0.92	50.42	1.86	35.52
2667	"	J. H. Pugh, "	0.63	45.99	4.07	36.33
2668	"	Louis M. Boykin, "	4.42	58.03	0.98	12.99
2669	Coprolites	Spencer Merritt, "	0.41	32.16	3.91	50.73
2670	"	J. D. Carter, "	0.51	44.99	5.25	37.70
2671	"	J. H. Pugh, "	0.56	36.04	4.71	44.82
2672	"	L. A. Powell, "	0.47	52.53	5.68	32.22
2673	"	D. B. Nicholson, "	0.39	53.43	6.43	29.47
2739	Black massive rock	J. B. King, Faison	0.56	60.29	3.52	26.52
2740	Phos. rock massive	A. H. King, "	0.87	42.97	4.11	39.51
2741	Gray phos. massive	J. C. Hobbs, Hobbs Cross Roads	0.14	61.54	2.68	28.16
2753	Phosphate rock	F. M. Herring, Clinton	0.42	58.68	4.18	27.42
2814	Coprolites	John D. Carr, "	0.49	8.06	18.66	54.01
	Stokes Co.					
4023	Limestone	L. H. Hill, Germantown	-----	------	86.47	------
4517	"	W. A. Lash, Walnut Cove	----	43.58	53.05	------
4518	"	" "	-----	49.58	42.74	------
	Wayne Co.					
101	Marl	J. J. Whitehead, Raleigh	1.00	72.26	13.90	0.93
122	"	" "	4.52	19.34	74.54	0.30
121	"	B. F. Arrington, Goldsboro	4.05	51.28	38.27	1.40
125	"	" "	----	9.52	83.64	trace.
126	"	" "	-----	13.06	81.02	------
2242	"	George C. Moore, "	-----	59.75	29.72	---- .
2697	"	N. W. Musgrove, "	-----	75.67	18.12	1.00

* Potash, .76 per cent. Considerable ferrous oxide is present and renders this marl injurious.

Number.	KIND.	NAME AND ADDRESS OF SENDER OR OWNER.	Moisture.	Sand and Insoluble Matter.	Carbonate of Lime.	Phosphate of Lime.
3407	White shell marl	J. W. Isler, Goldsboro	1.11	51.53	42.85	1.00
3159	Marl	J. H. Parks, "	----	81.36	2.14	2.38
4960	"	T. B. Parker, "	1.87	57.19	40.94	trace.
4961	"	" "	7.30	51.22	41.48	"
6614	Lime rock	Jno. R. Smith, "	----	53.15	40.03	10.90
7154	Marl	J. P. Cox, Walter	----	74.95	14.77	1.00
7254	"	" "	----	35.74	36.80	11.32
	Wilson Co.					
468	Blue marl	F. M. Roundtree, Wilson	1.07	78.36	21.64	------
499	Blue clay marl	Jas. Bryant, Wilson	4.30	81.90	13.80	------
500	Shell marl	" "	----	16.48	71.59	------
671	Phosphatic marl	W. P. Carraway, Wilson	1.71	19.90	38.87	4.45
673	Marl	" "	3.58	63.37	12.42	------
1013	Phosphatic marl	Jesse Mercer, Toisnot	1.38	85.56	4.10	7.38
3096	Yellow, earthy mrl	A. G. Brooks, Black Creek	----	86.07	0.82	1.53
3097	" "	" "	----	89.96	2.07	1.64
3098	White shell marl	" "	----	86.24	2.53	1.46
3099	" "	" "	----	80.19	4.21	1.57
4203	" "	H. Winstead, Toisnot	2.26	84.68	8.40	0.50
4787	Marl	A. G. Brooks, Black Creek	0.62	89.30	4.23	1.96

THE MANUFACTURE OF ACID PHOSPHATE FROM MINERAL PHOSPHATES.

While the beneficial effects of bone manure has been known from early times, its value as a plant food did not begin to be thoroughly appreciated until after the year 1840, when Liebig first published his theory of plant nutrition. His suggestion at this time that the phosphate of lime in bones could be converted into a valuable fertilizer by treatment with sulphuric acid, and the carrying of this suggestion into practical effect by Sir John B. Lawes, brought into existence the chemical fertilizer and phosphate industry, which has gradually been developed until at the present time it has attained enormous proportions. The world's estimated production of raw phosphates in 1880 was about 500,000 tons, while in 1890 it was about 1,303,000 tons, an increase in ten years of over 160 per cent. Of this enormous amount, the United States alone produced nearly one-half, the principal sources of which were from the beds in South Carolina and Florida.

The greater part of this raw material was consumed in the manufacture of superphosphates, or acid phosphates, which means a production in 1890 of over 2,000,000 tons. The increasing demand for phosphate manures during the past few years has not only stimulated the discovery and exploration of new fields, but large sums of money have been expended for erecting extensive and costly plants for the manufacture of these materials. Most of these establishments are not only equipped with every facility for acidulating and mixing fertilizers, but are also provided with large lead chambers for the manufacture of sulphuric acid, one of the essential constituents of acid phosphate. Improved machinery, the substitution of iron pyrites for sulphur in the manufacture of sulphuric acid, and closer competition, both with reference to the producers and manufacturers, has brought the price down to a reasonably low basis. It would not, therefore, be either practicable or profitable for the average farmer to endeavor to engage in the acidulating of ground phosphate for home consumption, but he should at least have some knowledge of their manufacture, composition and value. While the manufacture of acid phosphate from mineral phosphates is neither very complex nor difficult, the process is not very generally understood. The ever-varying composition of the raw materials makes it impossible, even for the experienced manufacturer, to obtain the best results without the assistance of a chemical analysis. It is, therefore, not only necessary to have a certain amount of practical experience to conduct a business of this kind successfully, but also some knowl-

edge of chemistry and chemical methods is of the utmost importance. There are several phosphates found in nature, but the one most used in the manufacture of fertilizers is the tri-calcium phosphate ($Ca_3 P_2 O_8$), which is made up of three molecules or parts of lime (CaO) and one molecule or part of phosphoric anhydride ($P_2 O_5$). In this form, phosphate of lime is not soluble in water, and very slowly decomposed by the action of the soil and plant juices. The method for making this material soluble or available as plant food, which is now in universal use, is the same as was first introduced by Liebig, that is, by treating the ground rock with a sufficient amount of sulphuric acid ($H_2 SO_4$) to convert the insoluble phosphate into a soluble or available form. Sulphuric acid, being more energetic in its action than other common acids, has the power of displacing most other acids from their salts and taking their bases to form sulphates. If the crude phosphates were pure tri-calcium phosphate, the chemist could easily calculate the amount of sulphuric acid required for complete reduction, which would be applicable in all cases; but as these materials always contain admixtures of other substances, these impurities must be considered in calculating the amount of acid to be used. The amount of monohydrated sulphuric acid required to make acid phosphate of pure tri-calcic phosphate may be calculated from the following chemical equation:

$$\underset{310}{Ca_3 P_2 O_8} + \underset{196}{2H_2 SO_4} = 2CaSO_4 + CaH_4 P_2 O_8.$$

molecular weights.

From this will be seen that 310 parts calcium phosphate requires 196 parts of sulphuric acid for complete reduction, or for every 100 pounds of phosphate 63.2 pounds of pure sulphuric acid must be used; but all mineral phosphates, as already stated, contain impurities which must be considered in calculating the full amount of acid to be used. For instance, by a further calculation of the necessary chemical equations, it is ascertained that 100 pounds of ferric oxide requires 183.8 pounds of pure sulphuric acid.

100 pounds of alumina requires 288.3 pounds of pure sulphuric acid.

100 pounds of calcium carbonate requires 98 pounds of pure sulphuric acid.

100 pounds of magnesium carbonate requires 116.6 pounds of pure sulphuric acid.

100 pounds calcium fluoride requires 125.6 pounds pure sulphuric acid.*

* Florida Experiment Station, Bulletin No. 10.

With the information thus furnished, there should be no trouble in dealing with any phosphate, when the composition is accurately known. For example:

Analysis of phosphate.	Per cent.	*Sulphuric acid required.*	Pounds.
Phosphate of lime	79.40	79.40 × 63.2 =	50.18
Carbonate of lime	5.48	5.48 × 98. =	5.37
Ferric oxide	0.72	0.72 × 183.8 =	1.32
Alumina	3.00	3.00 × 288.3 =	8 65
Calcium fluoride	3.20	3.20 × 125.6 =	4.02
			69.54

The total quantity of pure sulphuric acid required for every 100 pounds of rock of the above composition is found to be 69.54 pounds to bring the insoluble phosphates into a soluble and available form.

The above calculation is based on pure monohydrate sulphuric acid, but the ordinary "*chamber acid*" of the trade contains considerable water and other impurities, for which due allowance must be made. This acid is usually measured with a Beaumé hydrometer, and the strength expressed in degrees Beaumé, which corresponds to the following percentage:*

Degrees Beaumé at 60° F.	Percentage of SO_3 (anhydride).	Percentage of H_2SO_4 (monohydrate).
48	48.70	59.63
49	49.80	61.00
50	51.00	62.47
51	52.20	63.94
52	53.50	65.53
53	54.90	67.30
54	56.00	68.60
55	57.10	69.94

Assuming the acid used to be of 55° B. strength, we refer to the table and find that it contains 69.94 per cent. of pure sulphuric acid. The quantity to be taken as an equivalent of 69.54 pounds of pure acid, is found by the following proportion: 69.94 : 100 :: 69.54 : x, whence x=99.43 pounds. Therefore 100 pounds of the ground rock of the composition given in the preceding example requires 99.43, or practically 100 pounds, of "*chamber acid*" of 55° B. strength.

Thus, by theory, 1 ton of ground rock mixed with 1 ton of acid will produce about 2 tons of first-class acid phosphate. While this is the case with much of the material it cannot be said to apply in every instance. There are certain other elements which affect the operation which can only be obtained by practical experience. It has been found that much depends upon the grinding, for a very finely pulverized rock is much more easily reduced than a coarser material. The presence of iron and alumina to any considerable

* This table is from Dr. F. T. Wyatt's "Phosphates of America," to whom credit should also be given for many points in this discussion.

extent is also a very troublesome factor. It not only takes a very large amount of acid, but when the theoretical amount is added it renders the mass sticky and very difficult to dry. On the other hand, if less than the theoretical amount of acid be used a certain amount will remain insoluble. These difficulties and many others constantly confront the manufacturer in dealing with refractory raw materials, the solution of which must be left to the skill and experience of the practical operator. In England the commercial value is based upon the percentage of water-soluble phosphoric acid, but in this country not only the water-soluble is considered, but also the percentage of phosphoric acid which is soluble in neutral ammonium citrate treated at 65° Centigrade, as well as the insoluble form in some states. The action of ammonium citrate is supposed to be as nearly like the action of the soil and plant juices as can be produced in an artificial way, and hence the term *available* is applied to all the phosphoric acid which is liberated by it, including the soluble form which is readily dissolved by pure water. The average marketable South Carolina rock contains about 60 per cent. of phosphate of lime, and should produce an acid phosphate containing from 13 to 15 per cent. of available phosphoric acid. Select rock from Florida is of a little higher grade, while that of North Carolina and other localities is somewhat inferior in quality.

The use of mineral fertilizers stands no longer on the defensive, as is shown by their tremendous development during the past twenty-five years, while their usefulness is so generally recognized now that their production and manufacture will continue with increased activity in future years.

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